1.0 General Description
The LM111, LM211 and LM311 are voltage comparators that have input currents nearly a thousand times lower than devices like the LM106 or LM710. They are also designed to operate over a wider range of supply voltages: from standard ±15V op amp supplies down to the single 5V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50V at currents as high as 50mA.
Both the inputs and the outputs of the LM111, LM211 or the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR’ed. Although slower than the LM106 and LM710 (200 ns response time vs 40 ns) the devices are also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.
The LM211 is identical to the LM111, except that its performance is specified over a –25°C to +85°C temperature range instead of –55°C to +125°C. The LM311 has a temperature range of 0°C to +70°C.

2.0 Features
- Operates from single 5V supply
- Input current: 150 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range: ±30V
- Power consumption: 135 mW at ±15V

3.0 Typical Applications (Note 3)

**Offset Balancing**

**Strobing**

**Increasing Input Stage Current** (Note 1)

**Detector for Magnetic Transducer**

*Note: Do Not Ground Strobe Pin. Output is turned off when current is pulled from Strobe Pin.*

*Note 1: Increases typical common mode slew from 7.0V/µs to 18V/µs.*
3.0 Typical Applications (Note 3) (Continued)

Digital Transmission Isolator

![Diagram of Digital Transmission Isolator](DS005704-40)

Relay Driver with Strobe

![Diagram of Relay Driver with Strobe](DS005704-41)

*Absorbs inductive kickback of relay and protects IC from severe voltage transients on \( V^+ \) line.

Note: Do Not Ground Strobe Pin.

Strobing off Both Input and Output Stages (Note 2)

![Diagram of Strobing off Both Input and Output Stages](DS005704-42)

Note: Do Not Ground Strobe Pin.

Note 2: Typical input current is 50 pA with inputs strobed off.

Note 3: Pin connections shown on schematic diagram and typical applications are for H08 metal can package.

Positive Peak Detector

![Diagram of Positive Peak Detector](DS005704-23)

Zero Crossing Detector Driving MOS Logic

![Diagram of Zero Crossing Detector Driving MOS Logic](DS005704-24)

*Solid tantalum
4.0 Absolute Maximum Ratings for the LM111/LM211 (Note 10)

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

- Total Supply Voltage ($V_{84}$): 36V
- Output to Negative Supply Voltage ($V_{74}$): 50V
- Ground to Negative Supply Voltage ($V_{14}$): 30V
- Differential Input Voltage: ±30V
- Input Voltage (Note 4): ±15V
- Output Short Circuit Duration: 10 sec

Operating Temperature Range
- LM111: -55°C to 125°C
- LM211: -25°C to 85°C

Lead Temperature (Soldering, 10 sec): 260°C

Voltage at Strobe Pin: V~ -5V

Soldering Information
- Dual-In-Line Package: Soldering (10 seconds) 260°C
- Small Outline Package: Vapor Phase (60 seconds) 215°C
- Infrared (15 seconds) 220°C

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

ESD Rating (Note 11): 300V

---

### Electrical Characteristics (Note 6)

for the LM111 and LM211

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Offset Voltage (Note 7)</td>
<td>$T_A=25^\circ\text{C}$, $R_S\leq50k$</td>
<td>0.7</td>
<td>3.0</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>4.0</td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>60</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>40</td>
<td>200</td>
<td>V/mV</td>
<td></td>
</tr>
<tr>
<td>Response Time (Note 8)</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>200</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>$V_{IN}\leq5$ mV, $I_{OUT}=50$ mA</td>
<td>0.75</td>
<td>1.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Strobe ON Current (Note 9)</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>2.0</td>
<td>5.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>$V_{IN}\geq5$ mV, $V_{OUT}=35V$</td>
<td>0.2</td>
<td>10</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Offset Voltage (Note 7)</td>
<td>$R_S\leq50k$</td>
<td>4.0</td>
<td></td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Input Offset Current (Note 7)</td>
<td></td>
<td>20</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Bias Current</td>
<td></td>
<td>150</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>$V^+=15V$, $V^-=15V$, Pin 7 Pull-Up May Go To 5V</td>
<td>-14.5</td>
<td>13.8, 14.7</td>
<td>13.0</td>
<td>V</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>$V^+\geq4.5V$, $V^-=0$</td>
<td>0.23</td>
<td>0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>$V_{IN}\leq6$ mV, $I_{OUT}=8$ mA</td>
<td>0.1</td>
<td>0.5</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Positive Supply Current</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>5.1</td>
<td>6.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>$T_A=25^\circ\text{C}$</td>
<td>4.1</td>
<td>5.0</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

Note 4: This rating applies for ±15 supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

Note 5: The maximum junction temperature of the LM111 is 150°C, while that of the LM211 is 110°C. For operating at elevated temperatures, devices in the H08 package must be derated based on a thermal resistance of 165°C/W, junction to ambient, or 20°C/W, junction to case. The thermal resistance of the dual-in-line package is 110°C/W, junction to ambient.

Note 6: These specifications apply for $V_S=\pm15V$ and Ground pin at ground, and $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, unless otherwise stated. With the LM211, however, all temperature specifications are limited to $-25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to ±15V supplies.

Note 7: The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and $R_S$.

Note 8: The response time specified (see definitions) is for a 100 mV Input step with 5 mV overdrive.

Note 9: This specification gives the range of current which must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.


Note 11: Human body model, 1.5 kΩ in series with 100 pF.
5.0 Absolute Maximum Ratings for the LM311 (Note 12)

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

- Total Supply Voltage \( (V_{84}) \) 36V
- Output to Negative Supply Voltage \( (V_{74}) \) 40V
- Ground to Negative Supply Voltage \( (V_{14}) \) 30V
- Differential Input Voltage \( \pm 30V \)
- Input Voltage (Note 13) \( \pm 15V \)
- Power Dissipation (Note 14) 500 mW
- ESD Rating (Note 19) 300V
- Output Short Circuit Duration 10 sec

**Electrical Characteristics** (Note 15)

for the LM311

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Offset Voltage (Note 16)</td>
<td>( T_A = 25˚C ), ( R_S \leq 50k )</td>
<td>2.0</td>
<td>7.5</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Input Offset Current (Note 16)</td>
<td>( T_A = 25˚C )</td>
<td>6.0</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>( T_A = 25˚C )</td>
<td>100</td>
<td>250</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>( T_A = 25˚C )</td>
<td>40</td>
<td>200</td>
<td>V/mV</td>
<td></td>
</tr>
<tr>
<td>Response Time (Note 17)</td>
<td>( T_A = 25˚C )</td>
<td>200</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>( V_{IN} \leq -10 \text{ mV}, I_{OUT} = 50 \text{ mA} )</td>
<td>0.75</td>
<td>1.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Strobe ON Current (Note 18)</td>
<td>( T_A = 25˚C )</td>
<td>2.0</td>
<td>5.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>( V_{IN} \geq 10 \text{ mV}, V_{OUT} = 35V )</td>
<td>( T_A = 25˚C ), ( I_{STROBE} = 3 \text{ mA} )</td>
<td>0.2</td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td>Input Offset Voltage (Note 16)</td>
<td>( R_S \leq 50K )</td>
<td>10</td>
<td></td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Input Offset Current (Note 16)</td>
<td></td>
<td>70</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Bias Current</td>
<td></td>
<td>300</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>( -14.5 )</td>
<td>13.8</td>
<td>14.7</td>
<td>13.0</td>
<td>V</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>( V^+ \geq 4.5V, V^- = 0 )</td>
<td>( V_{IN} \leq -10 \text{ mV}, I_{OUT} \leq 8 \text{ mA} )</td>
<td>0.23</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>Positive Supply Current</td>
<td>( T_A = 25˚C )</td>
<td>5.1</td>
<td>7.5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>( T_A = 25˚C )</td>
<td>4.1</td>
<td>5.0</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

**Note 12:** “Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.”

**Note 13:** This rating applies for ±15V supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

**Note 14:** The maximum junction temperature of the LM311 is 110˚C. For operating at elevated temperature, devices in the H08 package must be derated based on a thermal resistance of 165˚C/W, junction to ambient, or 20˚C/W, junction to case. The thermal resistance of the dual-in-line package is 100˚C/W, junction to ambient.

**Note 15:** These specifications apply for \( V_S = \pm 15V \) and Pin 1 at ground, and \( 0˚C < T_A < 70˚C \), unless otherwise specified. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to ±15V supplies.

**Note 16:** The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and \( R_S \).

**Note 17:** The response time specified (see definitions) is for a 100 mV input step with 5 mA overdrive.

**Note 18:** This specification gives the range of current which must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

**Note 19:** Human body model, 1.5 kΩ in series with 100 pF.
6.0 LM111/LM211 Typical Performance Characteristics

Input Bias Current

Input Bias Current

Input Bias Current

Input Overdrives

Input Overdrives

Input Overdrives

Input Overdrives

Input Overdrives

Input Overdrives

Input Overdrives

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6.0 LM111/LM211 Typical Performance Characteristics (Continued)

Response Time for Various Input Overdrives

[Graph showing response time for various input overdrives]

7.0 LM311 Typical Performance Characteristics

Response Time for Various Input Overdrives

[Graph showing response time for various input overdrives]

Output Limiting Characteristics

[Graph showing output limiting characteristics]

Supply Current

[Graph showing supply current]

Supply Current

[Graph showing supply current]

Leakage Currents

[Graph showing leakage currents]

Input Bias Current

[Graph showing input bias current]

Input Offset Current

[Graph showing input offset current]

Offset Error

[Graph showing offset error]
7.0 LM311 Typical Performance Characteristics (Continued)

**Input Characteristics**

![Input Characteristics Graph](DS005704-61)

**Common Mode Limits**

![Common Mode Limits Graph](DS005704-62)

**Transfer Function**

![Transfer Function Graph](DS005704-63)

**Response Time for Various Input Overdrives**

![Response Time Graph](DS005704-64)

**Response Time for Various Input Overdrives**

![Response Time Graph](DS005704-65)

**Output Saturation Voltage**

![Output Saturation Voltage Graph](DS005704-66)

**Response Time for Various Input Overdrives**

![Response Time Graph](DS005704-67)

**Response Time for Various Input Overdrives**

![Response Time Graph](DS005704-68)

**Output Limiting Characteristics**

![Output Limiting Characteristics Graph](DS005704-69)
8.0 Application Hints

8.1 CIRCUIT TECHNIQUES FOR AVOIDING OSCILLATIONS IN COMPARATOR APPLICATIONS

When a high-speed comparator such as the LM111 is used with fast input signals and low source impedances, the output response will normally be fast and stable, assuming that the power supplies have been bypassed (with 0.1 µF disc capacitors), and that the output signal is routed well away from the inputs (pins 2 and 3) and also away from pins 5 and 6.

However, when the input signal is a voltage ramp or a slow sine wave, or if the signal source impedance is high (1 kΩ to 100 kΩ), the comparator may burst into oscillation near the crossing-point. This is due to the high gain and wide bandwidth of comparators like the LM111. To avoid oscillation or instability in such a usage, several precautions are recommended, as shown in Figure 1 below.

1. The trim pins (pins 5 and 6) act as unwanted auxiliary inputs. If these pins are not connected to a trim-pot, they should be shorted together. If they are connected to a trim-pot, a 0.01 µF capacitor C1 between pins 5 and 6 will minimize the susceptibility to AC coupling. A smaller capacitor is used if pin 5 is used for positive feedback as in Figure 1.

2. Certain sources will produce a cleaner comparator output waveform if a 100 pF to 1000 pF capacitor C2 is connected directly across the input pins.

3. When the signal source is applied through a resistive network, Rs, it is usually advantageous to choose an Rs of substantially the same value, both for DC and for dynamic (AC) considerations. Carbon, tin-oxide, and metal-film resistors have all been used successfully in comparator input circuitry. Inductive wirewound resistors are not suitable.

4. When comparator circuits use input resistors (eg. summing resistors), their value and placement are particularly important. In all cases the body of the resistor should be close to the device or socket. In other words there should be very little lead length or printed-circuit foil run between comparator and resistor to radiate or pick up signals. The same applies to capacitors, pots, etc. For example, if Rs = 10 kΩ, as little as 5 inches of lead between the resistors and the input pins can result in oscillations that are very hard to damp. Twisting these input leads tightly is the only (second best) alternative to placing resistors close to the comparator.

5. Since feedback to almost any pin of a comparator can result in oscillation, the printed-circuit layout should be engineered thoughtfully. Preferably there should be a groundplane under the LM111 circuitry, for example, one side of a double-layer circuit card. Ground foil (or, positive supply or negative supply foil) should extend between the output and the inputs, to act as a guard. The foil connections for the inputs should be as small and compact as possible, and should be essentially surrounded by ground foil on all sides, to guard against capacitive coupling from any high-level signals (such as the output). If pins 5 and 6 are not used, they should be shorted together. If they are connected to a trim-pot, the trim-pot should be located, at most, a few inches away from the LM111, and the 0.01 µF capacitor should be installed. If this capacitor cannot be used, a shielding printed-circuit foil may be advisable between pins 6 and 7. The power supply bypass capacitors should be located within a couple inches of the LM111. (Some other comparators require the power-supply bypass to be located immediately adjacent to the comparator.)

6. It is a standard procedure to use hysteresis (positive feedback) around a comparator, to prevent oscillation, and to avoid excessive noise on the output because the comparator is a good amplifier for its own noise. In the circuit of Figure 2, the feedback from the output to the positive input will cause about 3 mV of hysteresis. However, if Rs is larger than 100 kΩ, such as 50 kΩ, it would not be reasonable to simply increase the value of the positive feedback resistor above 510 kΩ. The circuit of Figure 3 could be used, but it is rather awkward. See the notes in paragraph 7 below.

7. When both inputs of the LM111 are connected to active signals, or if a high-impedance signal is driving the positive input of the LM111 so that positive feedback would be disruptive, the circuit of Figure 1 is ideal. The positive feedback is to pin 5 (one of the offset adjustment pins). It is sufficient to cause 1 to 2 mV hysteresis and sharp transitions with input triangle waves from a few Hz to hundreds of kHz. The positive-feedback signal across the 82 Ω resistor swings 240 mV below the positive supply. This signal is centered around the nominal voltage at pin 5, so this feedback does not add to the VCGs of the comparator. As much as 8 mV of VCGs can be trimmed out, using the 5 kΩ pot and 3 kΩ resistor as shown.
8. These application notes apply specifically to the LM111, LM211, LM311, and LF111 families of comparators, and are applicable to all high-speed comparators in general, (with the exception that not all comparators have trim pins).

![Improved Positive Feedback Circuit](image1)

**FIGURE 1. Improved Positive Feedback**

![Conventional Positive Feedback Circuit](image2)

**FIGURE 2. Conventional Positive Feedback**
8.0 Application Hints (Continued)

9.0 Typical Applications (Pin numbers refer to H08 package)

**Zero Crossing Detector Driving MOS Switch**

**100 kHz Free Running Multivibrator**

- TTL or DTL fanout of two
9.0 Typical Applications (Pin numbers refer to H08 package) (Continued)

**10 Hz to 10 kHz Voltage Controlled Oscillator**

```
C1  1000 pF
10K
R1  150 pF
22K
R2  22K

Q1  2N3972
2N5019

Q2  2N3972

Q3  1N751

Q4  1N751

R3  330K

R4  47K

R5  5.1K

R6  22K

R7  10M

R8  20K

R9  10K

R10 1K

R11 1K

R12 3K

D1  1N452

D2  1N457

D3  1N452

D4  1N457

+15V

-15V

+15V

TRIANGULAR WAVE OUTPUT

SQUARE WAVE OUTPUT
```

*Adjust for symmetrical square wave time when \( V_{IN} = 5 \text{ mV} \)

†Minimum capacitance 20 pF. Maximum frequency 50 kHz

**Driving Ground-Referred Load**

```
+V

INPUT

5 mV TO 5V

-15V

V+

V−

+V

-15V

V+

V−
```

*Input polarity is reversed when using pin 1 as output.

**Using Clamp Diodes to Improve Response**

```
FROM LADDER NETWORK

ANALOG INPUT

TTL OUTPUT
```

**TTL Interface with High Level Logic**

```
INPUT\(^\dagger\)

R1  82K

R2  47K

R3  82K

C1 \(^\dagger\)

R4  82K

R5  1K

R6  1K

R7  1K

R8  1K

R9  1K

R10 1K

R11 1K

R12 3K

D1  1N452

D2  1N457

D3  1N452

D4  1N457

+15V

-15V

+15V

-15V

TRIANGULAR WAVE OUTPUT

SQUARE WAVE OUTPUT
```

*Values shown are for a 0 to 30V logic swing and a 15V threshold.

†May be added to control speed and reduce susceptibility to noise spikes.
9.0 Typical Applications (Pin numbers refer to H08 package) (Continued)

**Crystal Oscillator**

```
R1 100K
R2 100K
C1 10 pF
C2 0.1 μF
LM111
V* = 5V
R3 50K
R4 2K
```

**Comparator and Solenoid Driver**

```
D1 1N4001
Q1 2N5740
R1 2.2K
R2 3K
```

**Precision Squarer**

```
Q1 2N797
Q2 2N2222
Q3 2N2222
D1 1N914
R1 3.9k
R2 2.7k
R3 f 1.5k
R4 1.0k
R5 1.0k
R6 510
R7 2.2k
C1 1.5k
```

*Solid tantalum
†Adjust to set clamp level
9.0 Typical Applications  (Pin numbers refer to H08 package)  (Continued)

Low Voltage Adjustable Reference Supply

Positive Peak Detector

Zero Crossing Detector Driving MOS Logic

Negative Peak Detector

*Solid tantalum
9.0 Typical Applications (Pin numbers refer to H08 package) (Continued)

**Precision Photodiode Comparator**

- R2 sets the comparison level. At comparison, the photodiode has less than 5 mV across it, decreasing leakages by an order of magnitude.

**Switching Power Amplifier**

DS005704-26

DS005704-27
9.0 Typical Applications  (Pin numbers refer to H08 package)  (Continued)

Switching Power Amplifier

![Circuit Diagram]

DS005704-28
10.0 Schematic Diagram (Note 20)

Note 20: Pin connections shown on schematic diagram are for H08 package.
11.0 Connection Diagrams

**Metal Can Package**

Note: Pin 4 connected to case

**Top View**
Order Number LM111H, LM111H/883 (Note 21), LM211H or LM311H
See NS Package Number H08C

**Dual-In-Line Package**

Order Number LM111J-8, LM111J-8/883 (Note 21), LM311M, LM311MX or LM311N
See NS Package Number J08A, M08A or N08E

**Top View**
Order Number LM111J/883 (Note 21)
See NS Package Number J14A or N14A

**Order Number LM111W/883 (Note 21), LM111WG/883**
See NS Package Number W10A, WG10A

**Note 21:** Also available per JM38510/10304
12.0 Physical Dimensions inches (millimeters) unless otherwise noted

Metal Can Package (H)
Order Number LM111H, LM111H/883, LM211H or LM311H
NS Package Number H08C

Cavity Dual-In-Line Package (J)
Order Number LM111J-8, LM111J-8/883
NS Package Number J08A
12.0 Physical Dimensions

inches (millimeters) unless otherwise noted (Continued)

Dual-In-Line Package (J)
Order Number LM111J/883
NS Package Number J14A

Dual-In-Line Package (M)
Order Number LM311M, LM311MX
NS Package Number M08A
12.0 Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

Dual-In-Line Package (N)
Order Number LM311N
NS Package Number N08E

Order Number LM111W/883, LM111WG/883
NS Package Number W10A, WG10A
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.