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# LM111JAN

## Voltage Comparator

### General Description

The LM111 is a voltage comparator that has input currents nearly a thousand times lower than devices such as the LM106 or LM710. It is also designed to operate over a wider range of supply voltages: from standard  $\pm 15\text{V}$  op amp supplies down to the single 5V supply used for IC logic. The output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, it can drive lamps or relays, switching voltages up to 50V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111 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 device is also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.

### Features

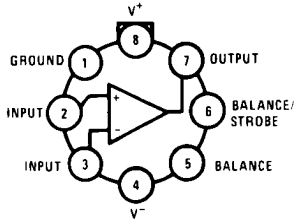
- Operates from single 5V supply
- Input current: 200 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range:  $\pm 30\text{V}$
- Power consumption: 135 mW at  $\pm 15\text{V}$
- Power supply voltage, single 5V to  $\pm 15\text{V}$
- Offset voltage null capability
- Strobe capability

### Ordering Information

| NS PART NUMBER | JAN PART NUMBER  | NS PACKAGE NUMBER | PACKAGE DESCRIPTION |
|----------------|------------------|-------------------|---------------------|
| JL111BCA       | JM38510/10304BCA | J14A              | 14LD CERDIP         |
| JL111BGA       | JM38510/10304BGA | H08C              | 8LD TO-99 Metal Can |
| JL111BHA       | JM38510/10304BHA | W10A              | 10LD CERPACK        |
| JL111BPA       | JM38510/10304BPA | J08A              | 8LD CERDIP          |
| JL111SGA       | JM38510/10304SGA | H08C              | 8LD TO-99 Metal Can |
| JL111SHA       | JM38510/10304SHA | W10A              | 10LD CERPACK        |
| JL111SPA       | JM38510/10304SPA | J08A              | 8LD CERDIP          |
| JL111SZA       | JM38510/10304SZA | WG10A             | 10LD Ceramic SOIC   |

# Connection Diagrams

## Metal Can Package

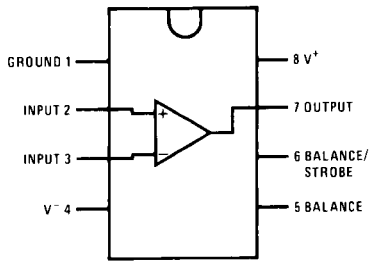


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Note: Pin 4 connected to case

Top View  
See NS Package Number H08C

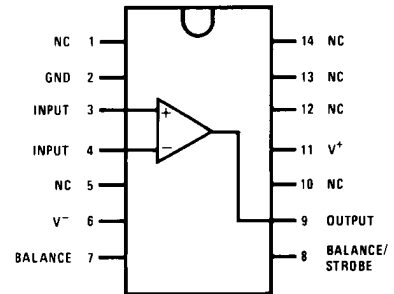
## Dual-In-Line Package



20142034

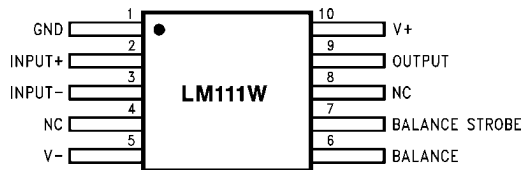
Top View  
See NS Package Number J08A

## Dual-In-Line Package



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Top View  
See NS Package Number J14A

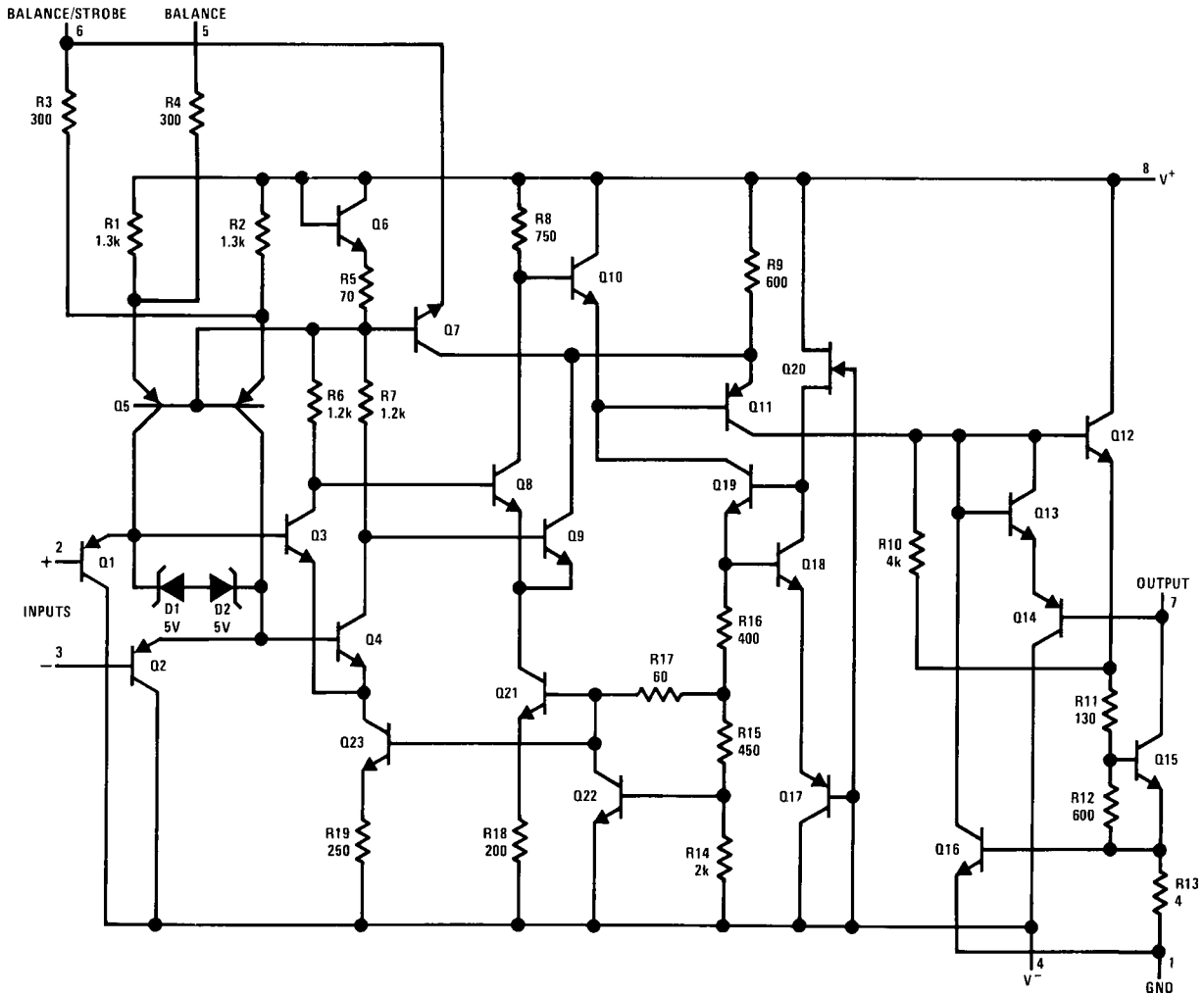


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See NS Package Number W10A, WG10A

# Schematic Diagram

(Note Pin connections shown on schematic diagram are for H08 package.)



20142005

**Note 1:** Pin connections shown on schematic diagram are for H08 package.

**Absolute Maximum Ratings** (Note 2)

|   |                                |
|---|--------------------------------|
| Positive Supply Voltage                     | +30.0V                         |
| Negative Supply Voltage                     | -30.0V                         |
| Total Supply Voltage                        | 36V                            |
| Output to Negative Supply Voltage           | 50V                            |
| GND to Negative Supply Voltage              | 30V                            |
| Differential Input Voltage                  | ±30V                           |
| Sink Current                                | 50mA                           |
| Input Voltage (Note 3)                      | ±15V                           |
| Power Dissipation (Note 4)                  |                                |
| 8 LD CERDIP                                 | 400mW @ 25°C                   |
| 8 LD Metal Can                              | 330mW @ 25°C                   |
| 10 LD CERPACK                               | 330mW @ 25°C                   |
| 10 LD Ceramic SOIC                          | 330mW @ 25°C                   |
| 14 LD CERDIP                                | 400mW @ 25°C                   |
| Output Short Circuit Duration               | 10 seconds                     |
| Maximum Strobe Current                      | 10mA                           |
| Operating Temperature Range                 | -55°C ≤ T <sub>A</sub> ≤ 125°C |
| Thermal Resistance                          |                                |
| θ <sub>JA</sub>                             |                                |
| 8 LD CERDIP (Still Air @ 0.5W)              | 120°C/W                        |
| 8 LD CERDIP (500LF/Min Air flow @ 0.5W)     | 76°C/W                         |
| 8 LD Metal Can (Still Air @ 0.5W)           | 150°C/W                        |
| 8 LD Metal Can (500LF/Min Air flow @ 0.5W)  | 92°C/W                         |
| 10 Ceramic SOIC (Still Air @ 0.5W)          | 231°C/W                        |
| 10 Ceramic SOIC (500LF/Min Air flow @ 0.5W) | 153°C/W                        |
| 10 CERPACK (Still Air @ 0.5W)               | 231°C/W                        |
| 10 CERPACK (500LF/Min Air flow @ 0.5W)      | 153°C/W                        |
| 14 LD CERDIP (Still Air @ 0.5W)             | 120°C/W                        |
| 14 LD CERDIP (500LF/Min Air flow @ 0.5W)    | 65°C/W                         |
| θ <sub>Jc</sub>                             |                                |
| 8 LD CERDIP                                 | 35°C/W                         |
| 8 LD Metal Can Pkg                          | 40°C/W                         |
| 10 LD Ceramic SOIC                          | 60°C/W                         |
| 10 LD CERPACK                               | 60°C/W                         |
| 14 LD CERDIP                                | 35°C/W                         |
| Storage Temperature Range                   | -65°C ≤ T <sub>A</sub> ≤ 150°C |
| Maximum Junction Temperature                | 175°C                          |
| Lead Temperature (Soldering, 60 seconds)    | 300°C                          |
| Voltage at Strobe Pin                       | V+ -5V                         |
| Package Weight (Typical)                    |                                |
| 8 LD Metal Can                              | 965mg                          |
| 8 LD CERDIP                                 | 1100mg                         |
| 10 LD CERPACK                               | 250mg                          |
| 10 LD Ceramic SOIC                          | 225mg                          |
| 14 LD CERDIP                                | TBD                            |
| ESD Rating (Note 5)                         | 300V                           |

## Recommended Operating Conditions

Supply Voltage

$$V_{CC} = \pm 15V_{DC}$$

Operating Temperature Range

$$-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$$

## Quality Conformance Inspection

Mil-Std-883, Method 5005 — Group A

| Subgroup | Description         | Temperature (°C) |
|----------|---------------------|------------------|
| 1        | Static tests at     | +25              |
| 2        | Static tests at     | +125             |
| 3        | Static tests at     | -55              |
| 4        | Dynamic tests at    | +25              |
| 5        | Dynamic tests at    | +125             |
| 6        | Dynamic tests at    | -55              |
| 7        | Functional tests at | +25              |
| 8A       | Functional tests at | +125             |
| 8B       | Functional tests at | -55              |
| 9        | Switching tests at  | +25              |
| 10       | Switching tests at  | +125             |
| 11       | Switching tests at  | -55              |

## LM111 JAN Electrical Characteristics

### DC Parameters

The following conditions apply, unless otherwise specified.

DC:  $V_{CC} = \pm 15V$ ,  $V_{CM} = 0$

| Symbol       | Parameter                         | Conditions   | Notes     | Min  | Max  | Unit | Sub-groups |
|--------------|-----------------------------------|--|-----------|------|------|------|------------|
| $V_{IO}$     | Input Offset Voltage              | $V_I = 0V$ , $R_S = 50\Omega$  |           | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.0 | +4.0 | mV   | 2, 3       |
|              |                                   | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50\Omega$  |           | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.0 | +4.0 | mV   | 2, 3       |
|              |                                   | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50\Omega$  |           | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.0 | +4.0 | mV   | 2, 3       |
| $V_{IO R}$   | Raised Input Offset Voltage       | $V_I = 0V$ , $R_S = 50\Omega$  | (Note 10) | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.5 | +4.5 | mV   | 2, 3       |
|              |                                   | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50\Omega$  | (Note 10) | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.5 | +4.5 | mV   | 2, 3       |
|              |                                   | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50\Omega$  | (Note 10) | -3.0 | +3.0 | mV   | 1          |
|              |                                   |  |           | -4.5 | +4.5 | mV   | 2, 3       |
| $I_{IO}$     | Input Offset Current              | $V_I = 0V$ , $R_S = 50K\Omega$   |           | -10  | +10  | nA   | 1, 2       |
|              |                                   |  |           | -20  | +20  | nA   | 3          |
|              |                                   | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50K\Omega$   |           | -10  | +10  | nA   | 1, 2       |
|              |                                   |  |           | -20  | +20  | nA   | 3          |
|              |                                   | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50K\Omega$   |           | -10  | +10  | nA   | 1, 2       |
|              |                                   |  |           | -20  | +20  | nA   | 3          |
| $I_{IO R}$   | Raised Input Offset Current       | $V_I = 0V$ , $R_S = 50K\Omega$   | (Note 10) | -25  | +25  | nA   | 1, 2       |
|              |                                   |  |           | -50  | +50  | nA   | 3          |
| $\pm I_{IB}$ | Input Bias Current                | $V_I = 0V$ , $R_S = 50K\Omega$   |           | -100 | 0.1  | nA   | 1, 2       |
|              |                                   |  |           | -150 | 0.1  | nA   | 3          |
|              |                                   | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50K\Omega$   |           | -150 | 0.1  | nA   | 1, 2       |
|              |                                   |  |           | -200 | 0.1  | nA   | 3          |
|              |                                   | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50K\Omega$   |           | -150 | 0.1  | nA   | 1, 2       |
|              |                                   |  |           | -200 | 0.1  | nA   | 3          |
| $V_{OSt}$    | Collector Output Voltage (Strobe) | $+V_I = Gnd$ , $-V_I = 15V$ ,<br>$I_{St} = -3mA$ , $R_S = 50\Omega$  | (Note 7)  | 14   |      | V    | 1, 2, 3    |
| CMRR         | Common Mode Rejection             | $-28V \leq -V_{CC} \leq -0.5V$ , $R_S = 50\Omega$ , $2V \leq +V_{CC} \leq 29.5V$ , $R_S = 50\Omega$ , $-14.5V \leq V_{CM} \leq 13V$ , $R_S = 50\Omega$ |           | 80   |      | dB   | 1, 2, 3    |

| Symbol                     | Parameter                                    | Conditions   | Notes    | Min  | Max  | Unit                         | Sub-groups |
|----------------------------|--|--|----------|------|------|------------------------------|------------|
| $V_{OL}$                   | Low Level Output Voltage                     | $+V_{CC} = 4.5V, -V_{CC} = \text{Gnd},$<br>$I_O = 8\text{mA}, \pm V_I = 0.5V,$<br>$V_{ID} = -6\text{mV}$ | (Note 9) |      | 0.4  | V                            | 1, 2, 3    |
|                            |  | $+V_{CC} = 4.5V, -V_{CC} = \text{Gnd},$<br>$I_O = 8\text{mA}, \pm V_I = 3V,$<br>$V_{ID} = -6\text{mV}$   | (Note 9) |      | 0.4  | V                            | 1, 2, 3    |
|                            |  | $I_O = 50\text{mA}, \pm V_I = 13V,$<br>$V_{ID} = -5\text{mV}$  | (Note 9) |      | 1.5  | V                            | 1, 2, 3    |
|                            |  | $I_O = 50\text{mA}, \pm V_I = -14V,$<br>$V_{ID} = -5\text{mV}$   | (Note 9) |      | 1.5  | V                            | 1, 2, 3    |
| $I_{CEX}$                  | Output Leakage Current                       | $+V_{CC} = 18V, -V_{CC} = -18V,$<br>$V_O = 32V$  |          | -1.0 | 10   | nA                           | 1          |
|                            |  |  |          | -1.0 | 500  | nA                           | 2          |
| $I_{IL}$                   | Input Leakage Current                        | $+V_{CC} = 18V, -V_{CC} = -18V,$<br>$+V_I = +12V, -V_I = -17V$   |          | -5.0 | 500  | nA                           | 1, 2, 3    |
|                            |  |  |          | -5.0 | 500  | nA                           | 1, 2, 3    |
| $+I_{CC}$                  | Power Supply Current                         |  |          |      | 6.0  | mA                           | 1, 2       |
|                            |  |  |          |      | 7.0  | mA                           | 3          |
| $-I_{CC}$                  | Power Supply Current                         |  |          | -5.0 |      | mA                           | 1, 2       |
|                            |  |  |          | -6.0 |      | mA                           | 3          |
| $\Delta V_{IO} / \Delta T$ | Temperature Coefficient Input Offset Voltage | $25^\circ\text{C} \leq T \leq 125^\circ\text{C}$   | (Note 8) | -25  | 25   | $\mu\text{V}/^\circ\text{C}$ | 2          |
|                            |  | $-55^\circ\text{C} \leq T \leq 25^\circ\text{C}$   | (Note 8) | -25  | 25   | $\mu\text{V}/^\circ\text{C}$ | 3          |
| $\Delta I_O / \Delta T$    | Temperature Coefficient Input Offset Current | $25^\circ\text{C} \leq T \leq 125^\circ\text{C}$   | (Note 8) | -100 | 100  | $\text{pA}/^\circ\text{C}$   | 2          |
|                            |  | $-55^\circ\text{C} \leq T \leq 25^\circ\text{C}$   | (Note 8) | -200 | 200  | $\text{pA}/^\circ\text{C}$   | 3          |
| $I_{OS}$                   | Short Circuit Current                        | $V_O = 5V, t \leq 10\text{mS}, -V_I = 0.1V,$<br>$+V_I = 0V$  |          |      | 200  | mA                           | 1          |
|                            |  |  |          |      | 150  | mA                           | 2          |
|                            |  |  |          |      | 250  | mA                           | 3          |
| $+V_{IO \text{ adj.}}$     | Input Offset Voltage (Adjustment)            | $V_O = 0V, V_I = 0V, R_S = 50\Omega$   |          | 5.0  |      | mV                           | 1          |
| $-V_{IO \text{ adj.}}$     | Input Offset Voltage (Adjustment)            | $V_O = 0V, V_I = 0V, R_S = 50\Omega$   |          |      | -5.0 | mV                           | 1          |
| $\pm A_{VE}$               | Voltage Gain (Emitter)                       | $R_L = 600\Omega$  | (Note 6) | 10   |      | V/mV                         | 4          |
|                            |  |  | (Note 6) | 8.0  |      | V/mV                         | 5, 6       |

## AC Parameters

The following conditions apply, unless otherwise specified.

AC:  $V_{CC} = \pm 15V, V_{CM} = 0$

| Symbol        | Parameter                        | Conditions  | Notes | Min | Max | Unit | Sub-groups |
|---------------|----------------------------------|---|-------|-----|-----|------|------------|
| $t_{R_{LHC}}$ | Response Time (Collector Output) | $V_{OD}(\text{Overdrive}) = -5\text{mV},$<br>$C_L = 50\text{pF}, V_I = -100\text{mV}$ |       |     | 300 | nS   | 7, 8B      |
|               |                                  |   |       |     | 640 | nS   | 8A         |
| $t_{R_{HLC}}$ | Response Time (Collector Output) | $V_{OD}(\text{Overdrive}) = 5\text{mV},$<br>$C_L = 50\text{pF}, V_I = 100\text{mV}$   |       |     | 300 | nS   | 7, 8B      |
|               |                                  |   |       |     | 500 | nS   | 8A         |



## DC Drift Parameters

The following conditions apply, unless otherwise specified.

DC:  $V_{CC} = \pm 15V$ ,  $V_{CM} = 0$

Delta calculations performed on JANS devices at group B, subgroup 5.

| Symbol       | Parameter              | Conditions   | Notes | Min   | Max  | Unit | Sub-groups |
|--------------|------------------------|--|-------|-------|------|------|------------|
| $V_{IO}$     | Input Offset Voltage   | $V_I = 0V$ , $R_S = 50\Omega$  |       | -0.5  | 0.5  | mV   | 1          |
|              |                        | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50\Omega$  |       | -0.5  | 0.5  | mV   | 1          |
|              |                        | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50\Omega$        |       | -0.5  | 0.5  | mV   | 1          |
| $\pm I_{IB}$ | Input Bias Current     | $V_I = 0V$ , $R_S = 50K\Omega$   |       | -12.5 | 12.5 | nA   | 1          |
|              |                        | $+V_{CC} = 29.5V$ , $-V_{CC} = -0.5V$ ,<br>$V_I = 0V$ , $V_{CM} = -14.5V$ ,<br>$R_S = 50K\Omega$ |       | -12.5 | 12.5 | nA   | 1          |
|              |                        | $+V_{CC} = 2V$ , $-V_{CC} = -28V$ ,<br>$V_I = 0V$ , $V_{CM} = +13V$ ,<br>$R_S = 50K\Omega$       |       | -12.5 | 12.5 | nA   | 1          |
| $I_{CEX}$    | Output Leakage Current | $+V_{CC} = 18V$ , $-V_{CC} = -18V$ ,<br>$V_O = 32V$  |       | -5.0  | 5.0  | nA   | 1          |

**Note 2:** 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. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

**Note 3:** This rating applies for  $\pm 15V$  supplies. The positive input voltage limit is 30 V 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 4:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{Jmax}$  (maximum junction temperature),  $\theta_{JA}$  (package junction to ambient thermal resistance), and  $T_A$  (ambient temperature). The maximum allowable power dissipation at any temperature is  $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

**Note 5:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

**Note 6:** Datalog reading in K=V/mV.

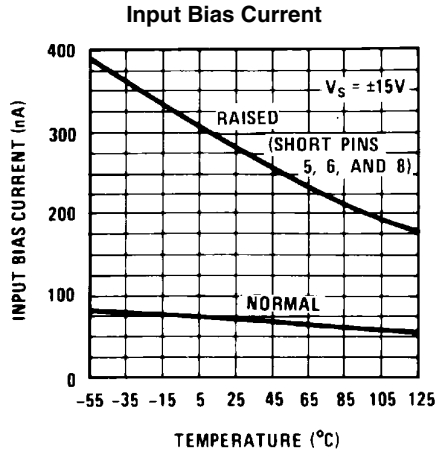
**Note 7:**  $I_{ST} = -2mA$  at  $-55^\circ C$

**Note 8:** Calculated parameter.

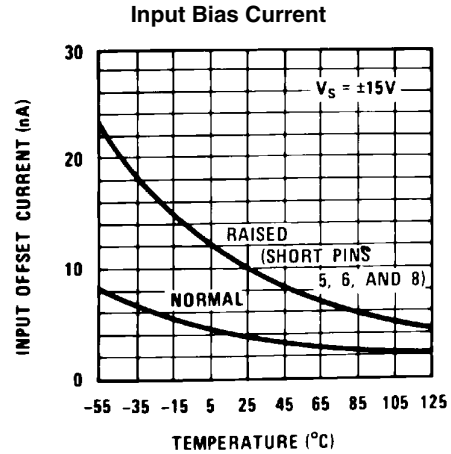
**Note 9:**  $V_{ID}$  is voltage difference between inputs.

**Note 10:** Subscript (R) indicates tests which are performed with input stage current raised by connecting BAL and BAL/STB terminals to  $+V_{CC}$ .

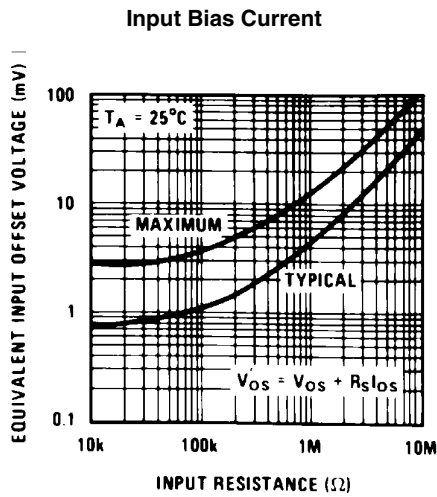
# LM111 Typical Performance Characteristics



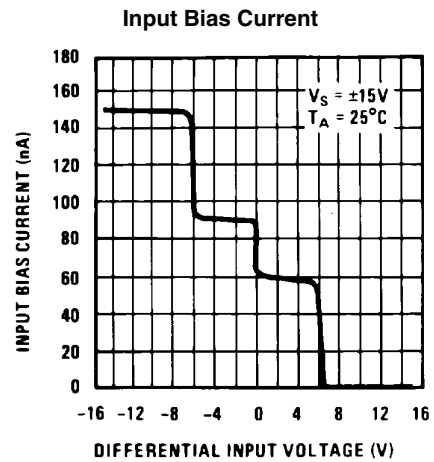
20142043



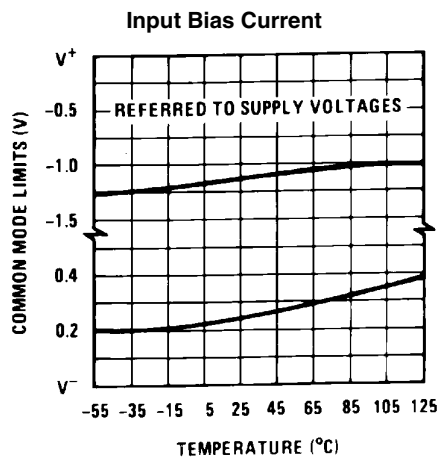
20142044



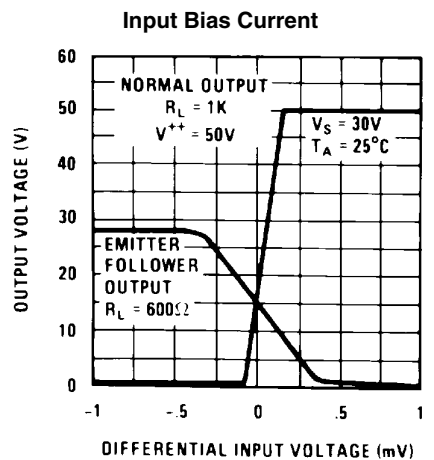
20142045



20142046

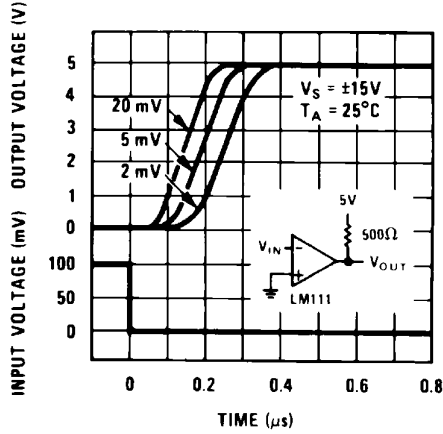


20142047



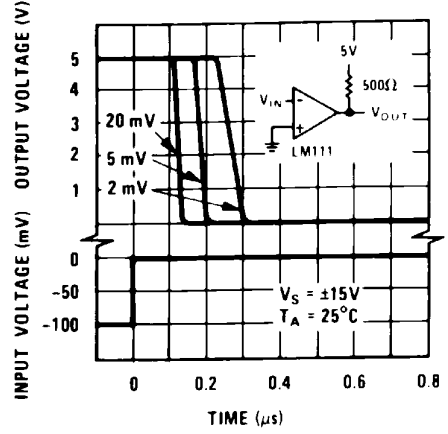
20142048

Input Bias Current  
Input Overdrives



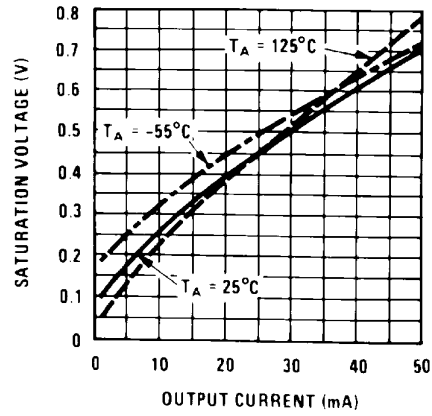
20142049

Input Bias Current  
Input Overdrives



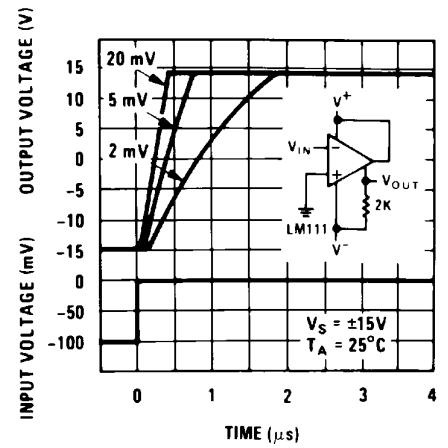
20142050

Input Bias Current



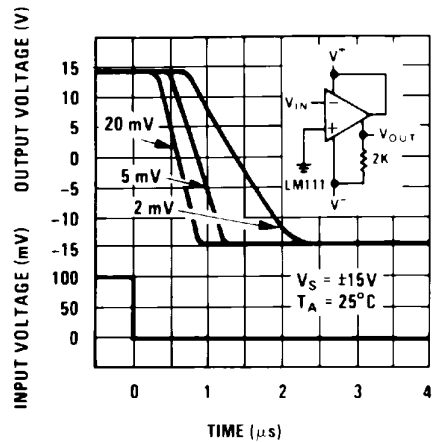
20142051

Response Time for Various  
Input Overdrives



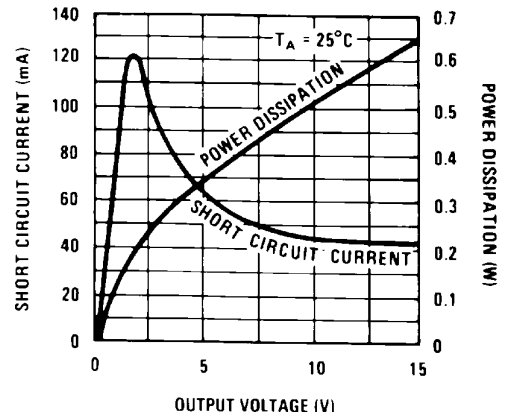
20142052

Response Time for Various  
Input Overdrives

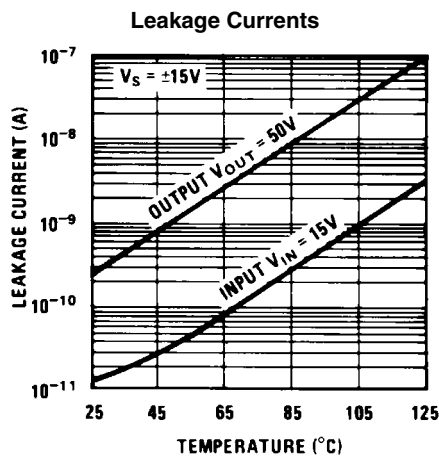
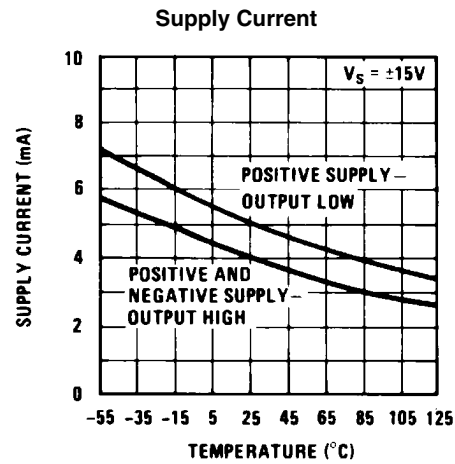
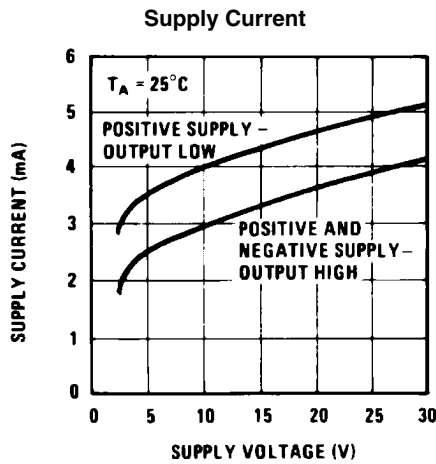


20142053

Output Limiting Characteristics



20142054



## Application Hints

### 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  $\mu\text{F}$  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.

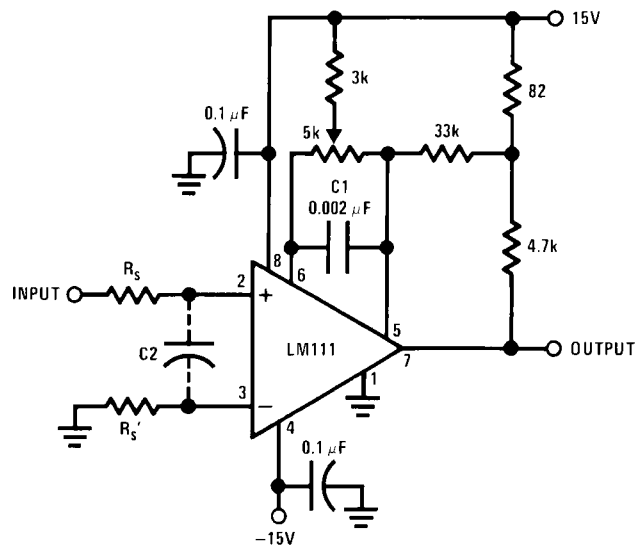
However, when the input signal is a voltage ramp or a slow sine wave, or if the signal source impedance is high (1 k $\Omega$  to 100 k $\Omega$ ), the comparator may burst into oscillation near the crossing-point. This is due to the high gain and wide bandwidth of comparators such as the LM111. To avoid 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  $\mu\text{F}$  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,  $R_S$ , it is usually advantageous to choose an  $R_S$  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 wire wound resistors are not suitable.
4. When comparator circuits use input resistors (e.g. 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  $R_S=10$  k $\Omega$ , 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 ground plane 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  $\mu\text{F}$  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  $R_S$  is larger than 100 $\Omega$ , such as 50 k $\Omega$ , it would not be reasonable to simply increase the value of the positive feedback resistor above 510 k $\Omega$ . The circuit

of *Figure 3* could be used, but it is rather awkward. See the notes in paragraph 7 below.

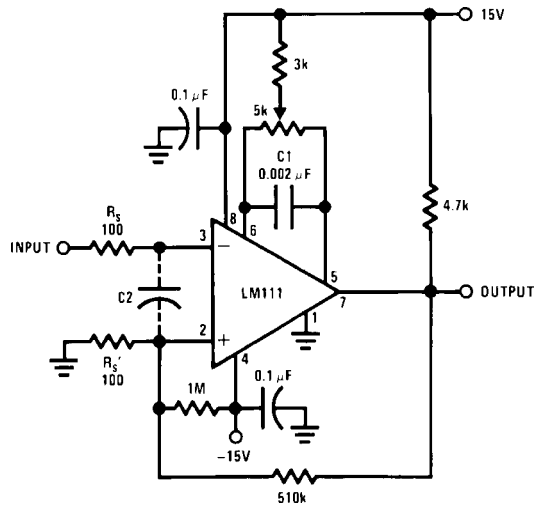
7. When both inputs of the LM111 are connected to active signals, or if a high-impedance signal is driving the positive input of the LM111 so that positive feedback would be disruptive, the circuit of *Figure 1* is ideal. The positive feedback is to pin 5 (one of the offset adjustment pins). It is sufficient 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 $\Omega$  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  $V_{OS}$  of the comparator. As much as 8 mV of  $V_{OS}$  can be trimmed out, using the 5 k $\Omega$  pot and 3 k $\Omega$  resistor as shown.
8. These application notes apply specifically to the LM111 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).



20142029

Pin connections shown are for LM111H in the H08 hermetic package

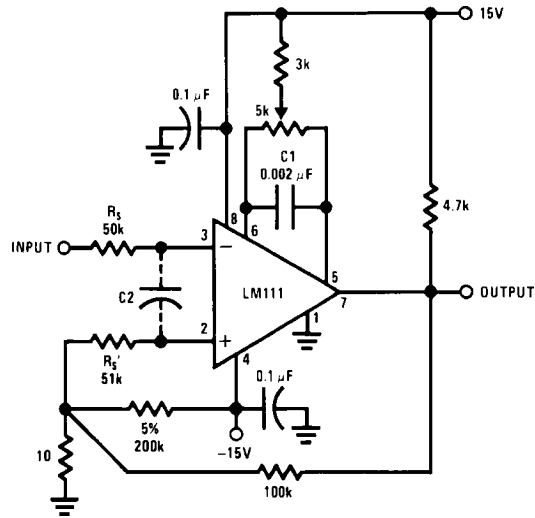
**FIGURE 1. Improved Positive Feedback**



20142030

Pin connections shown are for LM111H in the H08 hermetic package

FIGURE 2. Conventional Positive Feedback

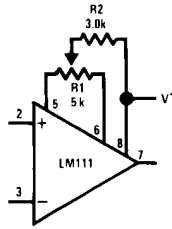


20142031

FIGURE 3. Positive Feedback with High Source Resistance

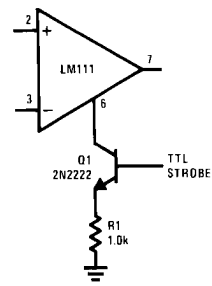
# Typical Applications (Note 13)

## Offset Balancing



20142036

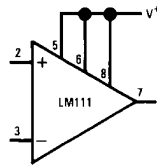
## Strobing



20142037

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

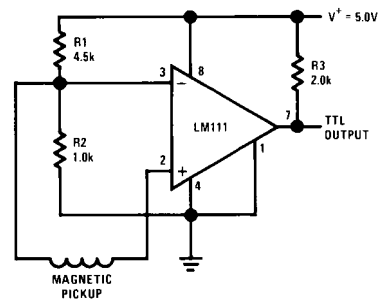
## Increasing Input Stage Current (Note Increases typical common mode slew from 7.0V/μs to 18V/μs.)



20142038

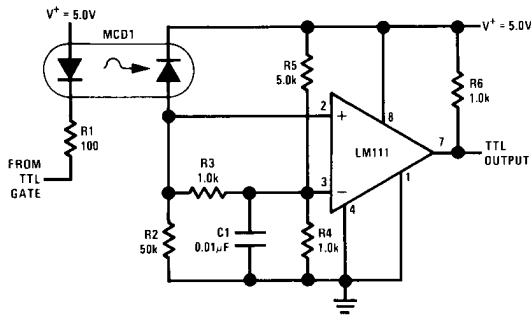
**Note 11:** Increases typical common mode slew from 7.0V/μs to 18V/μs.

## Detector for Magnetic Transducer



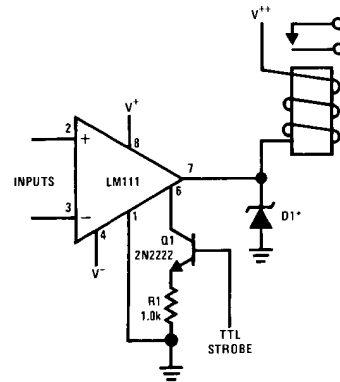
20142039

## Digital Transmission Isolator



20142040

## Relay Driver with Strobe

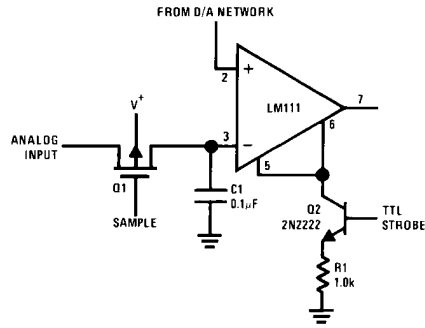


20142041

\*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 Typical input current is 50 pA with inputs strobed off.)



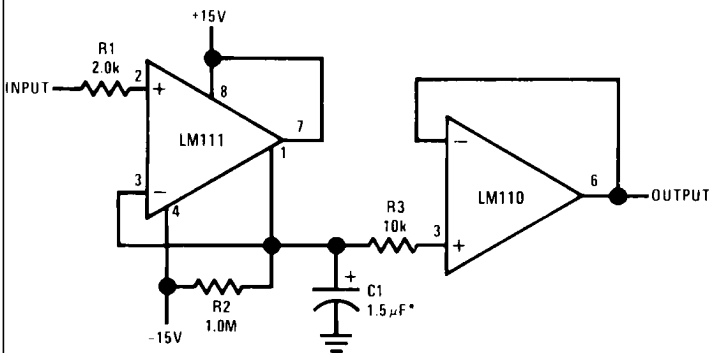
20142042

**Note:** Do Not Ground Strobe Pin.

**Note 12:** Typical input current is 50 pA with inputs strobed off.

**Note 13:** Pin connections shown on schematic diagram and typical applications are for H08 metal can package.

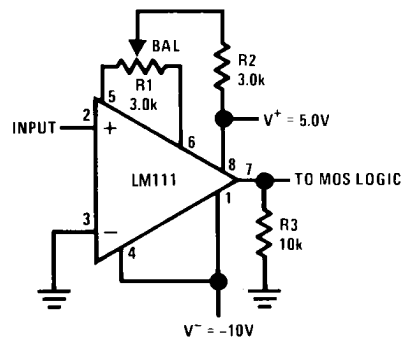
**Positive Peak Detector**



20142023

\*Solid tantalum

**Zero Crossing Detector Driving MOS Logic**

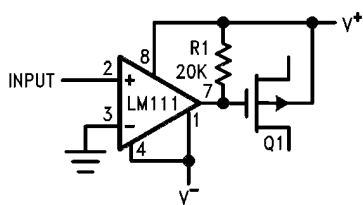


20142024

**Typical Applications**

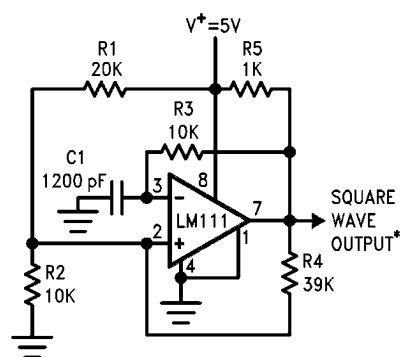
(Pin numbers refer to H08 package)

**Zero Crossing Detector Driving MOS Switch**



20142013

**100 kHz Free Running Multivibrator**

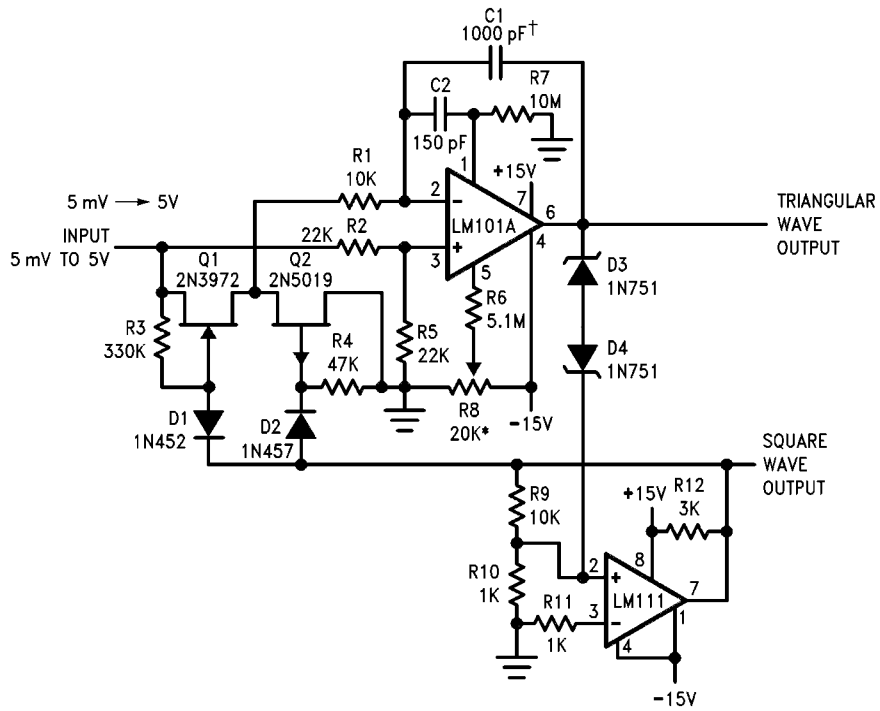


20142014

\*TTL or DTL fanout of two



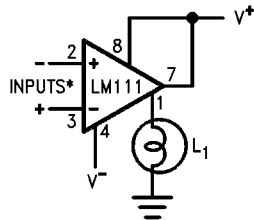
### 10 Hz to 10 kHz Voltage Controlled Oscillator



20142015

\*Adjust for symmetrical square wave time when  $V_{IN} = 5 \text{ mV}$   
 †Minimum capacitance 20 pF Maximum frequency 50 kHz

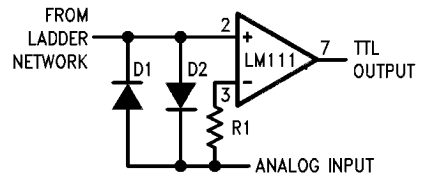
#### Driving Ground-Referred Load



20142016

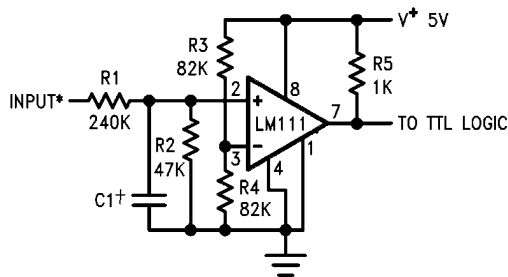
\*Input polarity is reversed when using pin 1 as output.

#### Using Clamp Diodes to Improve Response



20142017

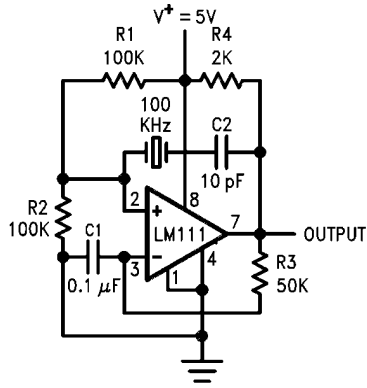
#### TTL Interface with High Level Logic



20142018

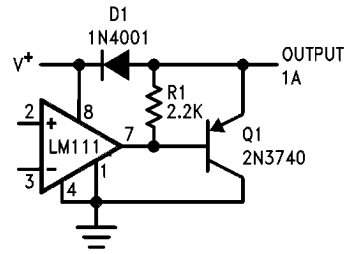
\*Values shown are for a 0 to 30V logic swing and a 15V threshold.  
 †May be added to control speed and reduce susceptibility to noise spikes.

**Crystal Oscillator**



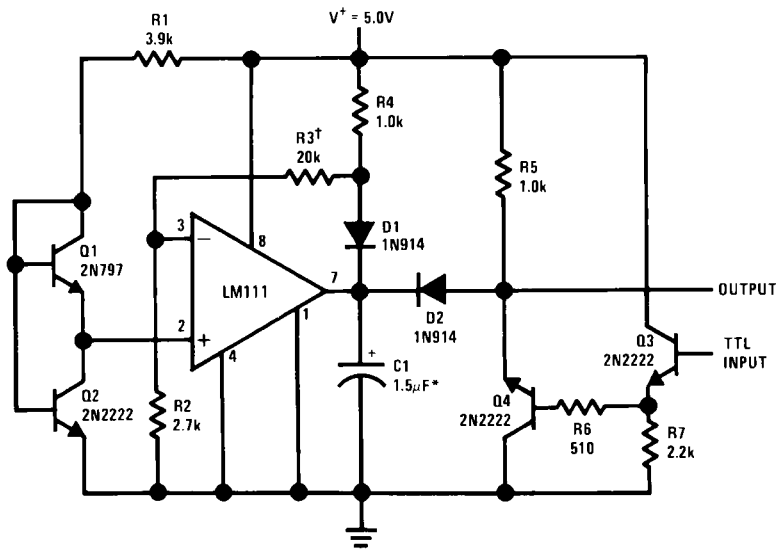
20142019

**Comparator and Solenoid Driver**



20142020

**Precision Squarer**

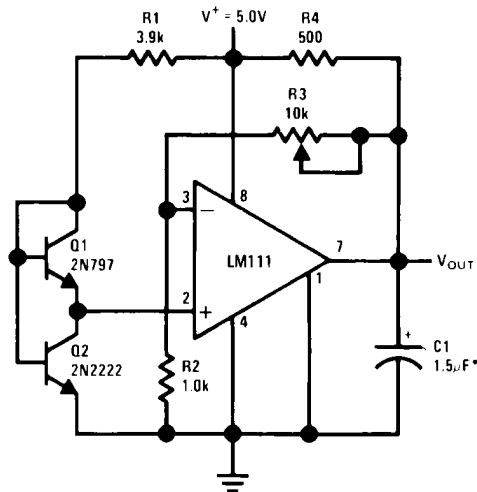


20142021

\*Solid tantalum

†Adjust to set clamp level

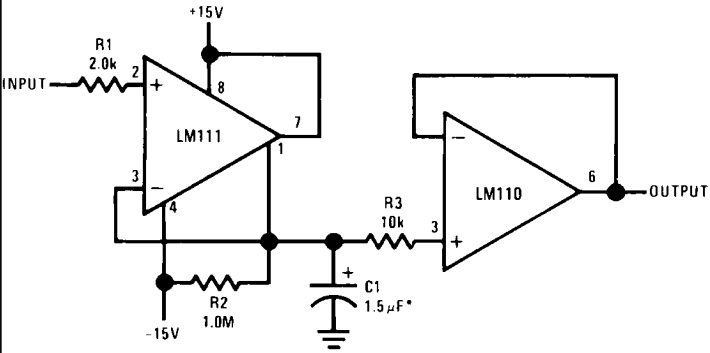
**Low Voltage Adjustable Reference Supply**



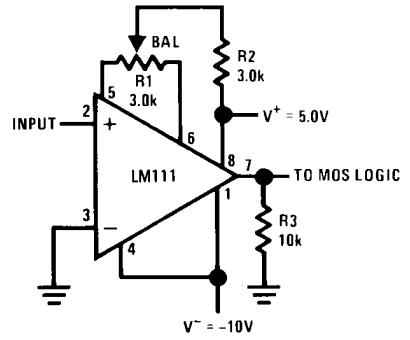
20142022

\*Solid tantalum

**Positive Peak Detector**



**Zero Crossing Detector Driving MOS Logic**

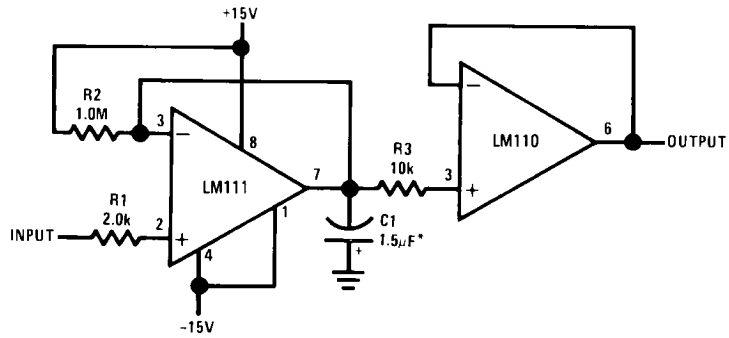


20142023

20142024

\*Solid tantalum

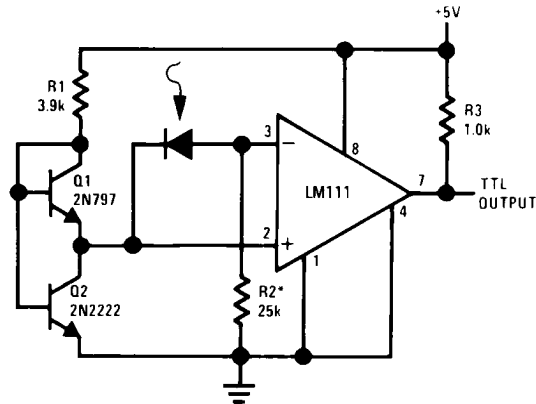
**Negative Peak Detector**



20142025

\*Solid tantalum

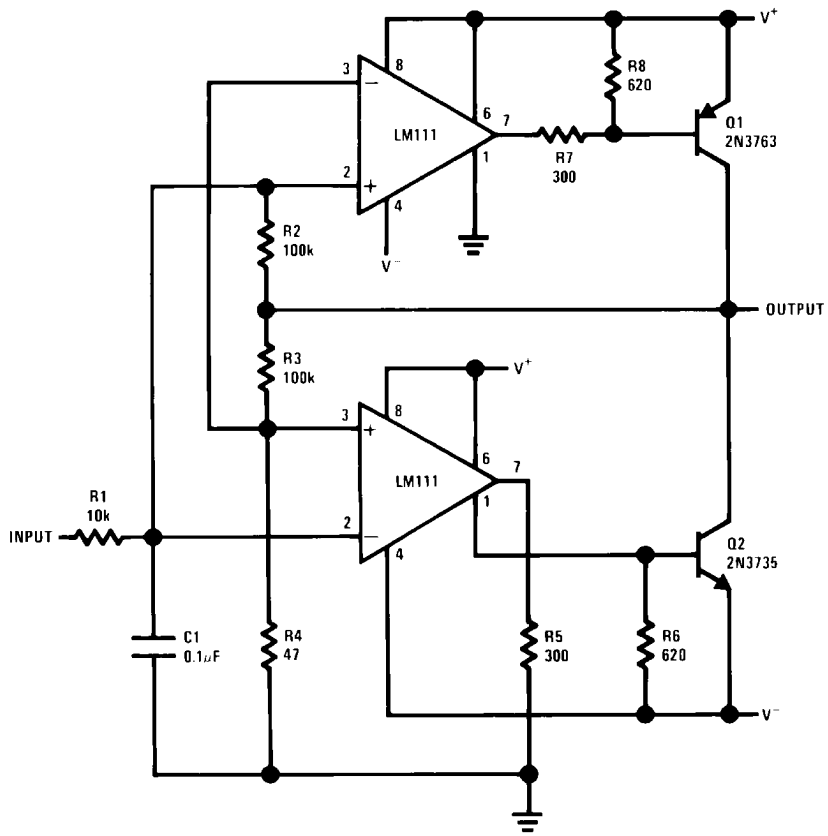
**Precision Photodiode Comparator**



20142026

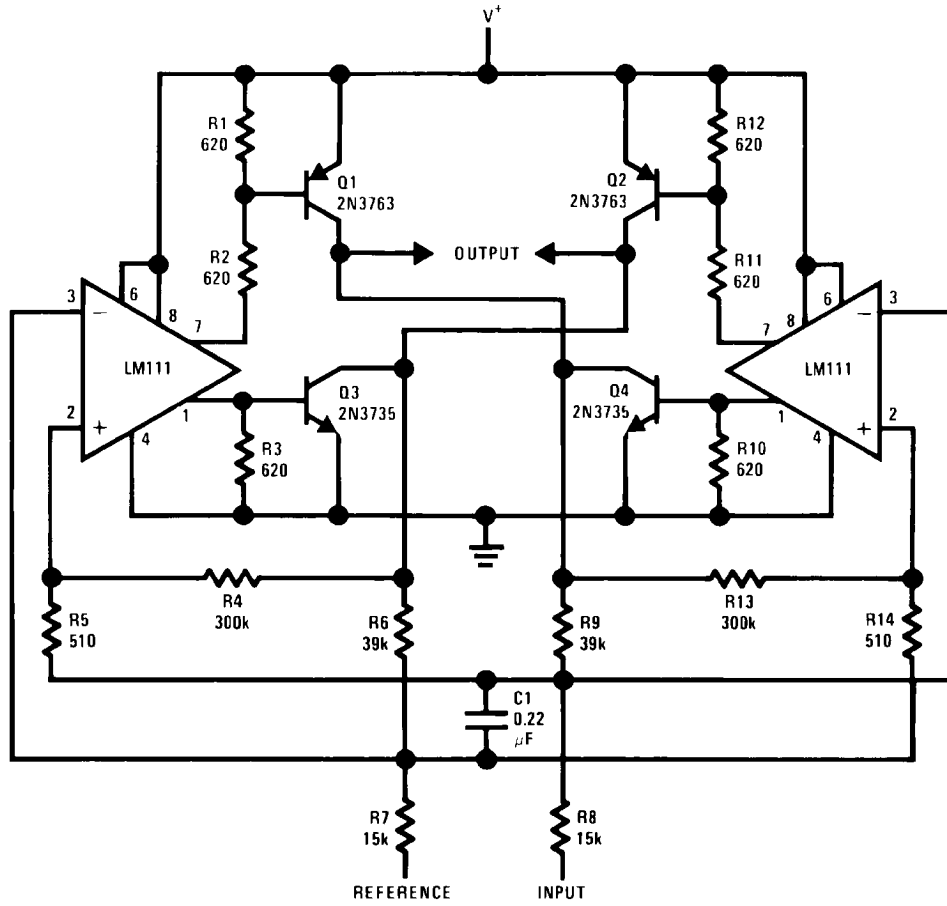
\*R2 sets the comparison level. At comparison, the photodiode has less than 5 mV across it, decreasing leakages by an order of magnitude.

### Switching Power Amplifier



20142027

### Switching Power Amplifier

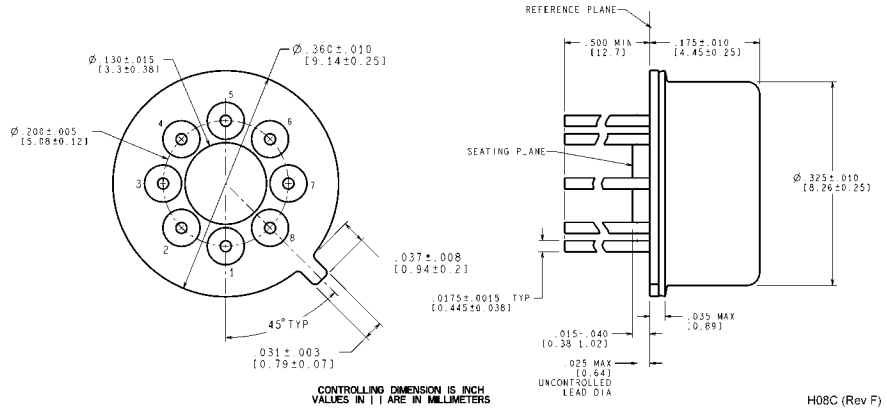


20142028

## Revision History Section

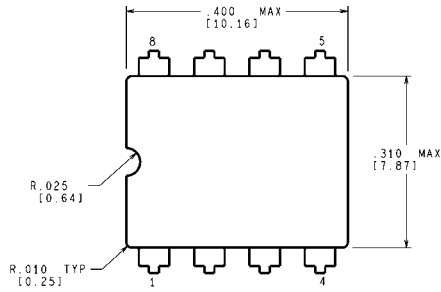
| Released | Revision | Section                       | Originator | Changes   |
|----------|----------|-------------------------------|------------|---|
| 05/09/05 | A        | New Release, Corporate format | L. Lytle   | 1 MDS data sheets converted into one Corp. data sheet format. MJLM111-X Rev 0D3 will be archived. |
|          |          |                               |            |   |

**Physical Dimensions** inches (millimeters) unless otherwise noted

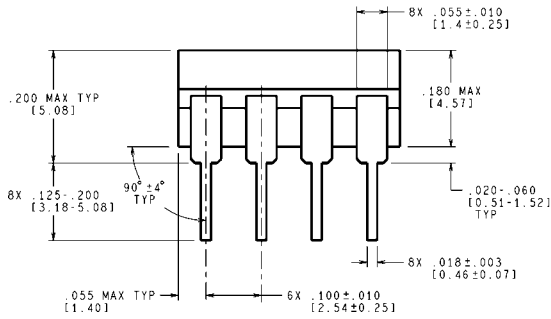


CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE IN MILLIMETERS  
**Metal Can Package (H)**  
**NS Package Number H08C**

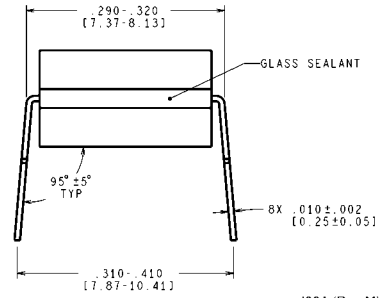
H08C (Rev F)



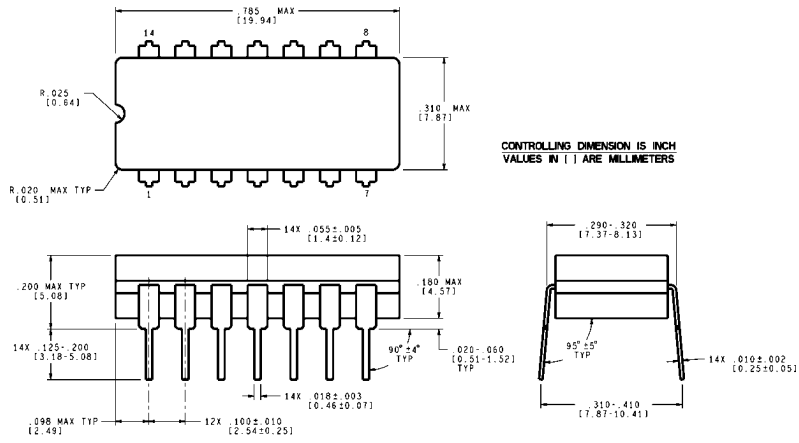
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**Cavity Dual-In-Line Package (J)**  
**NS Package Number J08A**

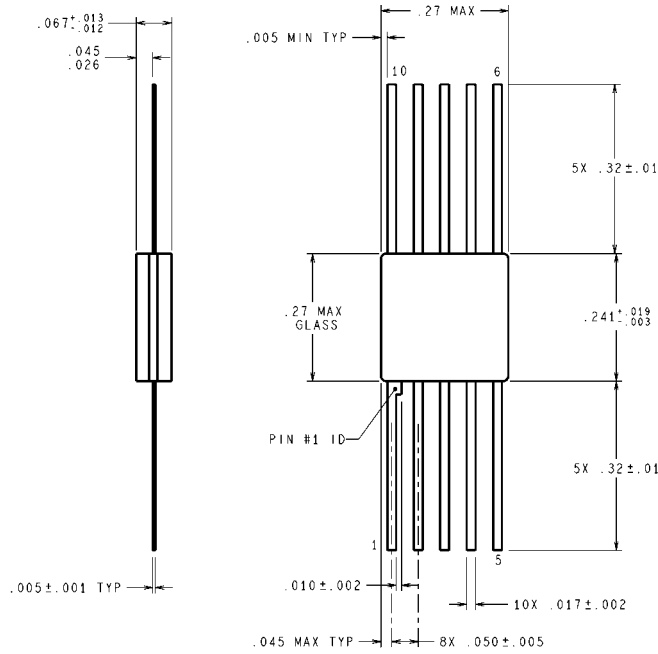


J08A (Rev M)



J14A (Rev J)

**Dual-In-Line Package (J)  
NS Package Number J14A**

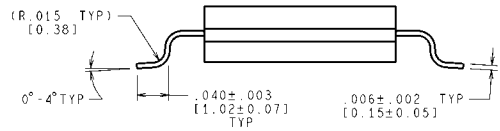
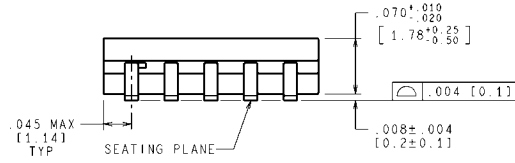
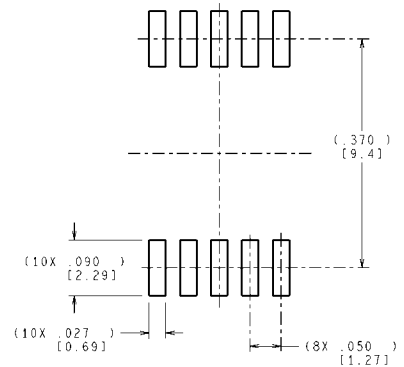
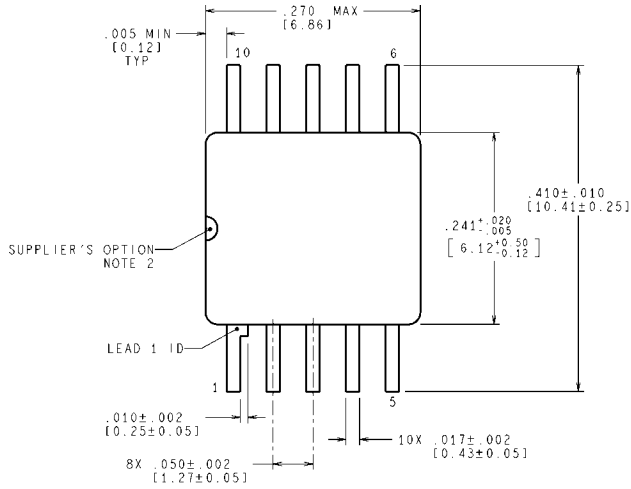


DIMENSIONS ARE IN INCHES

W10A (Rev H)

**Cerpack Package (W)  
NS Package Number W10A**





MIL-PRF-38535  
CONFIGURATION CONTROL

CONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

WG10A (Rev E)

**Cerpack Gull Wing Package (WG)**  
**NS Package Number WG10A**

# Notes

LM111JAN

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| Displays                       | <a href="http://www.national.com/displays">www.national.com/displays</a>       | Green Compliance        | <a href="http://www.national.com/quality/green">www.national.com/quality/green</a> |
| Ethernet                       | <a href="http://www.national.com/ethernet">www.national.com/ethernet</a>       | Packaging               | <a href="http://www.national.com/packaging">www.national.com/packaging</a>         |
| Interface                      | <a href="http://www.national.com/interface">www.national.com/interface</a>     | Quality and Reliability | <a href="http://www.national.com/quality">www.national.com/quality</a>             |
| LVDS                           | <a href="http://www.national.com/lvds">www.national.com/lvds</a>               | Reference Designs       | <a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>       |
| Power Management               | <a href="http://www.national.com/power">www.national.com/power</a>             | Feedback                | <a href="http://www.national.com/feedback">www.national.com/feedback</a>           |
| Switching Regulators           | <a href="http://www.national.com/switchers">www.national.com/switchers</a>     |                         |  |
| LDOs                           | <a href="http://www.national.com/lido">www.national.com/lido</a>               |                         |  |
| LED Lighting                   | <a href="http://www.national.com/led">www.national.com/led</a>                 |                         |  |
| PowerWise                      | <a href="http://www.national.com/powerwise">www.national.com/powerwise</a>     |                         |  |
| Serial Digital Interface (SDI) | <a href="http://www.national.com/sdi">www.national.com/sdi</a>                 |                         |  |
| Temperature Sensors            | <a href="http://www.national.com/tempsensors">www.national.com/tempsensors</a> |                         |  |
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