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4 Revision History

Changes from Revision D (March 2013) to Revision E

Page

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section **1**

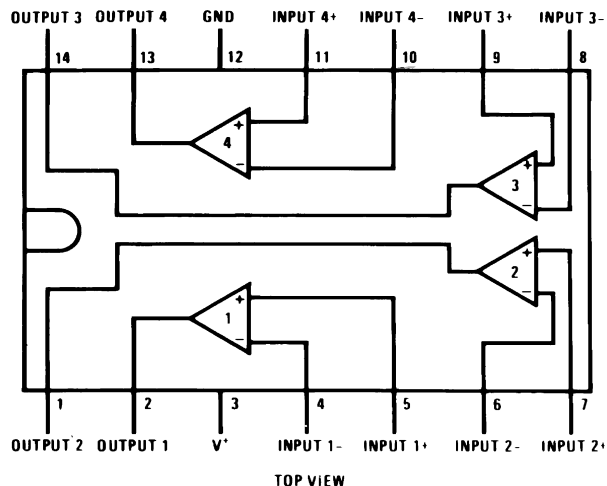
Changes from Revision C (March 2013) to Revision D

Page

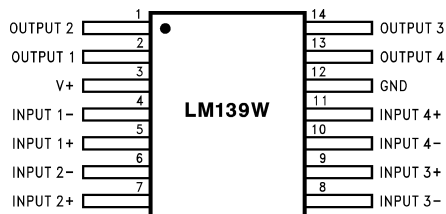
- Changed layout of National Data Sheet to TI format **10**

5 Pin Configuration and Functions

J, D and NFF Package
14-Pin CDIP, SOIC, PDIP
Top View



14-Pin CLGA Package
Top View



Pin Functions

| PIN | | I/O | DESCRIPTION |
|-----|---------|-----|-------------------------------|
| NO. | NAME | | |
| 1 | OUTPUT2 | O | Output, Channel 2 |
| 2 | OUTPUT1 | O | Output, Channel 1 |
| 3 | V+ | P | Positive Supply |
| 4 | INPUT1- | I | Inverting Input, Channel 1 |
| 5 | INPUT1+ | I | Noninverting Input, Channel 1 |
| 6 | INPUT2- | I | Inverting Input, Channel 2 |
| 7 | INPUT2+ | I | Noninverting Input, Channel 2 |
| 8 | INPUT3- | I | Inverting Input, Channel 3 |
| 9 | INPUT3+ | I | Noninverting Input, Channel 3 |
| 10 | INPUT4- | I | Inverting Input, Channel 4 |
| 11 | INPUT4+ | I | Noninverting Input, Channel 4 |
| 12 | GND | P | Ground |
| 13 | OUTPUT4 | O | Output, Channel 4 |
| 14 | OUTPUT3 | O | Output, Channel 3 |

6 Specifications

6.1 Absolute Maximum Ratings⁽¹⁾

| | | MIN | MAX | UNIT |
|--|--|--------------------------|------------|-----------------|
| Supply Voltage, V ⁺ | LM139N, LM239N, LM339N, LM2901N | | 36 | V _{DC} |
| | LM3302N | | 28 | |
| Differential Input Voltage | LM139N, LM239N, LM339N, LM2901N ⁽²⁾ | | 36 | |
| | LM3302N ⁽²⁾ | | 28 | |
| Input Voltage | LM139N, LM239N, LM339N, LM2901N | -0.3 | 36 | |
| | LM3302 | -0.3 | 28 | |
| Input Current (V _{IN} < -0.3 V _{DC}) ⁽³⁾ | | | 50 | mA |
| Power Dissipation ⁽⁴⁾ | PDIP | | 1050 | mW |
| | Cavity DIP | | 1190 | |
| | SOIC Package | | 760 | |
| Output Short-Circuit to GND ⁽⁵⁾ | | | Continuous | |
| Lead Temperature (Soldering, 10 seconds) | | | 260 | °C |
| Soldering Information | PDIP Package (10 seconds) | | 260 | |
| | SOIC Package | Vapor Phase (60 seconds) | 215 | |
| | | Infrared (15 seconds) | 220 | |
| Storage temperature, T _{stg} | | -65 | 150 | |

- (1) Refer to RETS139AX for LM139A military specifications and to RETS139X for LM139 military specifications.
- (2) 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 V_{DC} (or 0.3 V_{DC} below the magnitude of the negative power supply, if used) (at 25°C).
- (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 V_{DC} (at 25°C).
- (4) 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-N and LM139-N 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 ≤ 100 mW), provided the output transistors are allowed to saturate.
- (5) 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⁺.

6.2 ESD Ratings

| | | VALUE | UNIT |
|--------------------|-------------------------|---|-----------|
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±600 V |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

| | | | MIN | MAX | UNIT |
|-----------------------|---------------|---------------------------------|-----|-----|------|
| Supply Voltage | Single Supply | LM139N, LM239N, LM339N, LM2901N | 2 | 36 | V |
| | | LM3302N | 2 | 28 | |
| | Dual Supply | LM139N, LM239N, LM339N, LM2901N | ±1 | ±18 | |
| | | LM3302N | ±1 | ±14 | |
| Operating Temperature | LM139/LM139A | | -55 | 125 | °C |
| | LM2901/LM3302 | | -40 | 85 | |
| | LM239/LM239A | | -25 | 85 | |
| | LM339/LM339A | | 0 | 70 | |

6.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | LM139-N, LM239-N, LM339-N | LM2901-N, LM339-N | LM2901-N, LM339-N | UNIT |
|-------------------------------|--|---------------------------------|----------------------|----------------------|------|
| | | J | D | NFF | |
| | | 14 PINS | | | |
| R _{θJA} | Junction-to-ambient thermal resistance | 95 | 95 | 95 | °C/W |

 (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics: LM139A, LM239A, LM339A, LM139

 ($V^+ = 5 V_{DC}$, $T_A = 25^\circ\text{C}$ ⁽¹⁾ unless otherwise stated)

| PARAMETER | TEST CONDITIONS | LM139A | | | LM239A, LM339A | | | LM139 | | | UNIT | |
|---------------------------------|---|--------|-----|-------------|----------------|-----|-------------|-------|-----|-------------|---------------|-----------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | |
| Input Offset Voltage | See ⁽²⁾ | | 1.0 | 2.0 | | 1.0 | 2.0 | | 2.0 | 5.0 | mV_{DC} | |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range ⁽³⁾ , $V_{CM} = 0\text{ V}$ | | 25 | 100 | | 25 | 250 | | 25 | 100 | nA_{DC} | |
| Input Offset Current | $I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0\text{ V}$ | | 3.0 | 25 | | 5.0 | 50 | | 3.0 | 25 | nA_{DC} | |
| Input Common-Mode Voltage Range | $V^+ = 30 V_{DC}$ (LM3302, $V^+ = 28 V_{DC}$) ⁽⁴⁾ | 0 | | $V^+ - 1.5$ | 0 | | $V^+ - 1.5$ | 0 | | $V^+ - 1.5$ | V_{DC} | |
| Supply Current | (LM3302, $V^+ = 28 V_{DC}$), $R_L = \infty$ on all Comparators | | 0.8 | 2.0 | | 0.8 | 2.0 | | 0.8 | 2.0 | mA_{DC} | |
| | (LM3302, $V^+ = 28 V_{DC}$), $R_L = \infty$, $V^+ = 36\text{ V}$ | | | | | 1.0 | 2.5 | | 1.0 | 2.5 | mA_{DC} | |
| Voltage Gain | $R_L \geq 15\text{ k}\Omega$, $V^+ = 15 V_{DC}$ $V_O = 1 V_{DC}$ to $11 V_{DC}$ | 50 | | 200 | 50 | | 200 | 50 | | 200 | V/mV | |
| Large Signal Response Time | $V_{IN} = \text{TTL Logic Swing}$, $V_{REF} = 1.4 V_{DC}$, $V_{RL} = 5 V_{DC}$, $R_L = 5.1\text{ k}\Omega$ | | | 300 | | | 300 | | | 300 | ns | |
| Response Time | $V_{RL} = 5 V_{DC}$, $R_L = 5.1\text{ k}\Omega$ ⁽⁵⁾ | | | 1.3 | | | 1.3 | | | 1.3 | μs | |
| Output Sink Current | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $V_O \leq 1.5 V_{DC}$ | 6.0 | | 16 | 6.0 | | 16 | 6.0 | | 16 | mA_{DC} | |
| Saturation Voltage | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4\text{ mA}$ | | | 250 | 400 | | 250 | 400 | | 250 | 400 | mV_{DC} |
| Output Leakage Current | $V_{IN(+)} = 1 V_{DC}$, $V_{IN(-)} = 0$, $V_O = 5 V_{DC}$ | | | 0.1 | | | 0.1 | | | 0.1 | nA_{DC} | |
| Input Offset Voltage | See ⁽²⁾ | | | 4.0 | | | 4.0 | | | 9.0 | mV_{DC} | |
| Input Offset Current | $I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0\text{ V}$ | | | 100 | | | 150 | | | 100 | nA_{DC} | |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, $V_{CM} = 0\text{ V}$ ⁽³⁾ | | | 300 | | | 400 | | | 300 | nA_{DC} | |
| Input Common-Mode Voltage Range | $V^+ = 30 V_{DC}$ (LM3302), $V^+ = 28 V_{DC}$) ⁽⁴⁾ | 0 | | $V^+ - 2.0$ | 0 | | $V^+ - 2.0$ | 0 | | $V^+ - 2.0$ | V_{DC} | |
| Saturation Voltage | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4\text{ mA}$ | | | 700 | | | 700 | | | 700 | mV_{DC} | |
| Output Leakage Current | $V_{IN(+)} = 1 V_{DC}$, $V_{IN(-)} = 0$, $V_O = 30 V_{DC}$, (LM3302, $V_O = 28 V_{DC}$) | | | 1.0 | | | 1.0 | | | 1.0 | μA_{DC} | |
| Differential Input Voltage | Keep all V_{IN} 's $\geq 0 V_{DC}$ (or V^- , if used) ⁽⁶⁾ | | | 36 | | | 36 | | | 36 | V_{DC} | |

- (1) These specifications are limited to $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, for the LM139/LM139A. With the LM239/LM239A, all temperature specifications are limited to $-25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$, the LM339/LM339A temperature specifications are limited to $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$, and the LM2901, LM3302 temperature range is $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$.
- (2) At output switch point, $V_O = 1.4 V_{DC}$, $R_S = 0\ \Omega$ with V^+ from $5 V_{DC}$ to $30 V_{DC}$; and over the full input common-mode range ($0 V_{DC}$ to $V^+ - 1.5 V_{DC}$), at 25°C . For LM3302, V^+ from $5 V_{DC}$ to $28 V_{DC}$.
- (3) 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.
- (4) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V . The upper end of the common-mode voltage range is $V^+ - 1.5\text{ V}$ at 25°C , but either or both inputs can go to $30 V_{DC}$ without damage (25 V for LM3302), independent of the magnitude of V^+ .
- (5) 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.
- (6) 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 $-0.3 V_{DC}$ (or $0.3 V_{DC}$ below the magnitude of the negative power supply, if used) (at 25°C).

6.6 Electrical Characteristics: LM239, LM339, LM2901, LM3302

($V^+ = 5 V_{DC}$, $T_A = 25^\circ\text{C}$ ⁽¹⁾ unless otherwise stated)

| PARAMETER | TEST CONDITIONS | LM239, LM339 | | | LM2901 | | | LM3302 | | | UNIT |
|---------------------------------|---|--------------|-------------|-----|--------|-------------|-----|--------|-------------|-----|---------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | See ⁽²⁾ | 2.0 | 5.0 | | 2.0 | 7.0 | | 3 | 20 | | mV_{DC} |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range ⁽³⁾ , $V_{CM}=0\text{ V}$ | 25 | 250 | | 25 | 250 | | 25 | 500 | | nA_{DC} |
| Input Offset Current | $I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0\text{ V}$ | 5.0 | 50 | | 5 | 50 | | 3 | 100 | | nA_{DC} |
| Input Common-Mode Voltage Range | $V^+ = 30 V_{DC}$ (LM3302, $V^+ = 28 V_{DC}$) ⁽⁴⁾ | 0 | $V^+ - 1.5$ | | 0 | $V^+ - 1.5$ | | 0 | $V^+ - 1.5$ | | V_{DC} |
| Supply Current | (LM3302, $V^+ = 28 V_{DC}$) $R_L = \infty$ on all Comparators | 0.8 | 2.0 | | 0.8 | 2.0 | | 0.8 | 2.0 | | mA_{DC} |
| | (LM3302, $V^+ = 28 V_{DC}$) $R_L = \infty$, $V^+ = 36\text{ V}$ | 1.0 | 2.5 | | 1.0 | 2.5 | | 1.0 | 2.5 | | mA_{DC} |
| Voltage Gain | $R_L \geq 15\text{ k}\Omega$, $V^+ = 15 V_{DC}$ $V_O = 1 V_{DC}$ to $11 V_{DC}$ | 50 | 200 | | 25 | 100 | | 2 | 30 | | V/mV |
| Large Signal Response Time | $V_{IN} = \text{TTL Logic Swing}$, $V_{REF} = 1.4 V_{DC}$, $V_{RL} = 5 V_{DC}$, $R_L = 5.1\text{ k}\Omega$, | 300 | | | 300 | | | 300 | | | ns |
| Response Time | $V_{RL} = 5 V_{DC}$, $R_L = 5.1\text{ k}\Omega$ ⁽⁵⁾ | 1.3 | | | 1.3 | | | 1.3 | | | μs |
| Output Sink Current | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $V_O \leq 1.5 V_{DC}$ | 6.0 | 16 | | 6.0 | 16 | | 6.0 | 16 | | mA_{DC} |
| Saturation Voltage | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4\text{ mA}$ | 250 | 400 | | 250 | 400 | | 250 | 500 | | mV_{DC} |
| Output Leakage Current | $V_{IN(+)} = 1 V_{DC}$, $V_{IN(-)} = 0$, $V_O = 5 V_{DC}$ | 0.1 | | | 0.1 | | | 0.1 | | | nA_{DC} |
| Input Offset Voltage | See ⁽²⁾ | | 9.0 | | 9 | 15 | | | 40 | | mV_{DC} |
| Input Offset Current | $I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0\text{ V}$ | | 150 | | 50 | 200 | | | 300 | | nA_{DC} |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, $V_{CM} = 0V$ ⁽³⁾ | | 400 | | 200 | 500 | | | 1000 | | nA_{DC} |
| Input Common-Mode Voltage Range | $V^+ = 30 V_{DC}$ (LM3302, $V^+ = 28 V_{DC}$) | | $V^+ - 2.0$ | | 0 | $V^+ - 2.0$ | | 0 | $V^+ - 2.0$ | | V_{DC} |
| Saturation Voltage | $V_{IN(-)} = 1 V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4\text{ mA}$ | | 700 | | 400 | 700 | | | 700 | | mV_{DC} |
| Output Leakage Current | $V_{IN(+)} = 1 V_{DC}$, $V_{IN(-)} = 0$, $V_O = 30 V_{DC}$, (LM3302, $V_O = 28 V_{DC}$) | | 1.0 | | | 1.0 | | | 1.0 | | μA_{DC} |
| Differential Input Voltage | Keep all V_{IN} 's $\geq 0 V_{DC}$ (or V^- , if used) ⁽⁶⁾ | | 36 | | | 36 | | | 28 | | V_{DC} |

- (1) These specifications are limited to $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$, for the LM139/LM139A. With the LM239/LM239A, all temperature specifications are limited to $-25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$, the LM339/LM339A temperature specifications are limited to $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$, and the LM2901, LM3302 temperature range is $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$.
- (2) At output switch point, $V_O = 1.4 V_{DC}$, $R_S = 0\ \Omega$ with V^+ from $5 V_{DC}$ to $30 V_{DC}$; and over the full input common-mode range ($0 V_{DC}$ to $V^+ - 1.5 V_{DC}$), at 25°C . For LM3302, V^+ from $5 V_{DC}$ to $28 V_{DC}$.
- (3) 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.
- (4) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V . The upper end of the common-mode voltage range is $V^+ - 1.5V$ at 25°C , but either or both inputs can go to $30 V_{DC}$ without damage ($25V$ for LM3302), independent of the magnitude of V^+ .
- (5) 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.
- (6) 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 $-0.3 V_{DC}$ (or $0.3 V_{DC}$ below the magnitude of the negative power supply, if used) (at 25°C).

6.7 Typical Characteristics

6.7.1 LM139/LM239/LM339, LM139A/LM239A/LM339A, LM3302

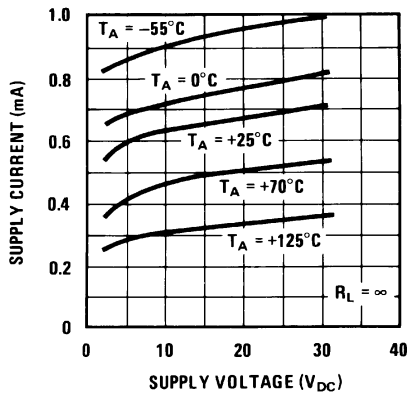


Figure 1. Supply Current

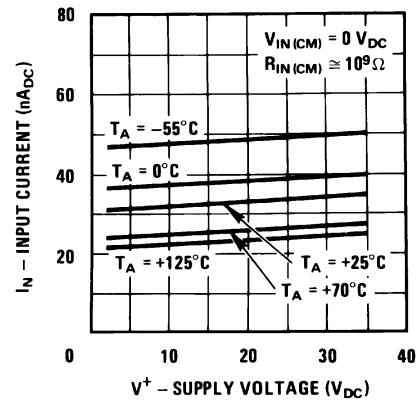


Figure 2. Input Current

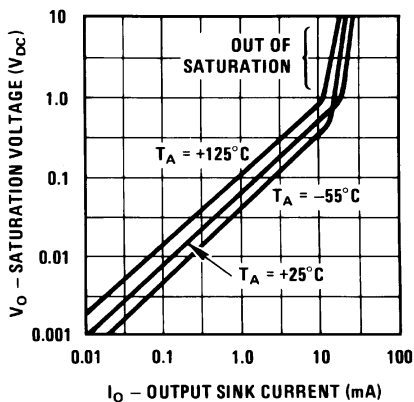


Figure 3. Output Saturation Voltage

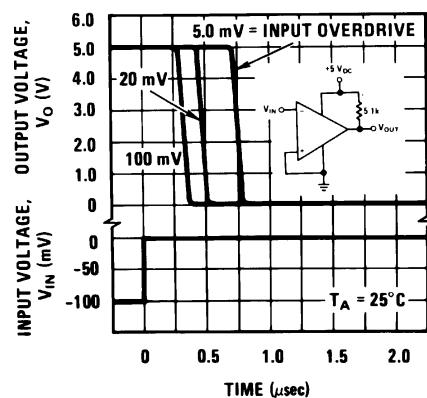


Figure 4. Response Time for Various Input Overdrives – Negative Transition



Figure 5. Response Time for Various Input Overdrives – Positive Transition

6.7.2 LM2901



Figure 6. Supply Current

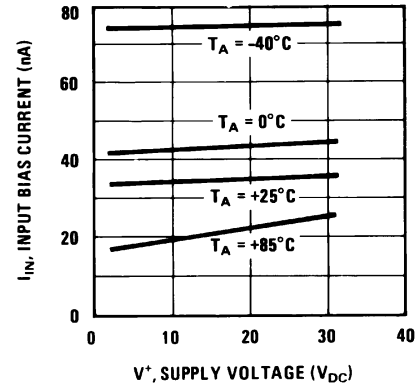


Figure 7. Input Current



Figure 8. Output Saturation Voltage

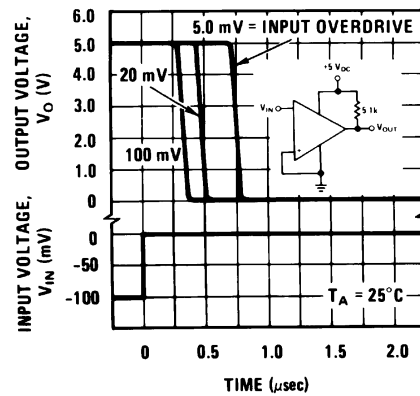


Figure 9. Response Time for Various Input Overdrives – Negative Transition

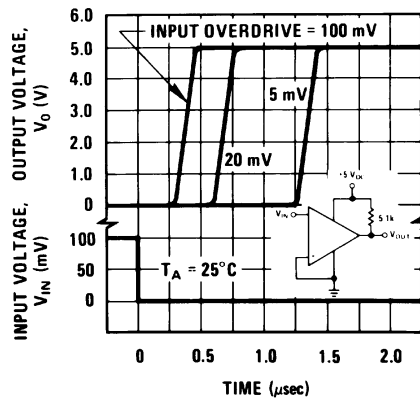


Figure 10. Response Time for Various Input Overdrives – Positive Transition

7 Detailed Description

7.1 Overview

The LM139/LM239/LM339 family of devices is a monolithic quad of independently functioning comparators designed to meet the needs for a medium-speed, TTL compatible comparator for industrial applications. Since no antisaturation clamps are used on the output such as a Baker clamp or other active circuitry, the output leakage current in the OFF state is typically 0.1 nA. This makes the device ideal for system applications where it is desired to switch a node to ground while leaving it totally unaffected in the OFF state. Other features include single supply, low voltage operation with an input common mode range from ground up to approximately one volt below V_{CC} . The output is an uncommitted collector so it may be used with a pullup resistor and a separate output supply to give switching levels from any voltage up to 36V down to a $V_{CE SAT}$ above ground (approximately 100 mV), sinking currents up to 16 mA. The open collector output configuration allows the device to be used in wired-OR configurations, such as a window comparators.

In addition it may be used as a single pole switch to ground, leaving the switched node unaffected while in the OFF state. Power dissipation with all four comparators in the OFF state is typically 4 mW from a single 5-V supply (1 mW/comparator).

7.2 Functional Block Diagram



7.3 Feature Description

The LMx39-N 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 through stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Reducing the input resistors to $< 10 \text{ k}\Omega$ 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.

The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than $-0.3 V_{DC}$ (at 25°C). An input clamp diode can be used as shown in the applications section.

The output of the LMx39-N series is the uncommitted collector of a grounded-emitter NPN output transistor. Many collectors can be tied together to provide an output OR'ing function. An output pullup resistor can be connected to any available power supply voltage within the permitted supply voltage range and there is no restriction on this voltage due to the magnitude of the voltage which is applied to the V^+ terminal of the LM139A package. The output can also be used as a simple SPST switch to ground (when a pullup resistor is not used).

Feature Description (continued)

The amount of current which the output device can sink is limited by the drive available (which is independent of V^+) and the β of this device. When the maximum current limit is reached (approximately 16 mA), the output transistor will come out of saturation and the output voltage will rise very rapidly. The output saturation voltage is limited by the approximately 60- Ω R_{SAT} of the output transistor. The low offset voltage of the output transistor (4 mV) allows the output to clamp essentially to ground level for small load currents.

7.4 Device Functional Modes

A basic comparator circuit is used for converting analog signals to a digital output. The output is HIGH when the voltage on the non-inverting (+IN) input is greater than the inverting (-IN) input. The output is LOW when the voltage on the noninverting (+IN) input is less than the inverting (-IN) input. The inverting input (-IN) is also commonly referred to as the "reference" or "VREF" input.

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

The bias network of the LMx39-N series establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2 V_{DC} to 30 V_{DC} .

8 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The LM139-N is specified for operation from 2.0 V to 36 V ($\pm 1\text{V}$ to $\pm 18\text{V}$) over the temperature range of -55°C to 125°C . While it may seem like a comparator has a well-defined and somewhat limited functionality as a '1-bit ADC', a comparator is a versatile component which can be used for many functions.

Refer to *AN-74 LM139/LM239/LM339 A Quad of Independently Functioning Comparators* ([SNOA654](#)) for additional application information on use of the LM139-N.

8.2 Typical Applications

8.2.1 Basic Comparator

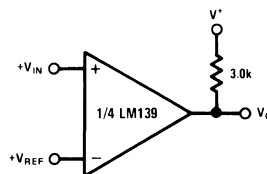


Figure 11. Basic Comparator Schematic

8.2.1.1 Design Requirements

The basic usage of a comparator is to indicate when a specific analog signal has exceeded some predefined threshold. In this application, the negative input is tied to a reference voltage, and the positive input is connected to the input signal. The output is pulled up with a resistor to the logic supply voltage, $V+$.

For an example application, the supply voltage is 5 V. The input signal varies between 1 V and 3 V, and we want to know when the input exceeds 2.5 V. For this example, we would set the V_{REF} to 2.5 V.

8.2.1.2 Application Curve



Figure 12. Basic Comparator Response

Typical Applications (continued)

8.2.2 System Examples

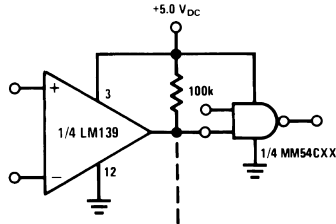


Figure 13. Driving CMOS
($V^+ = 5.0 V_{DC}$)

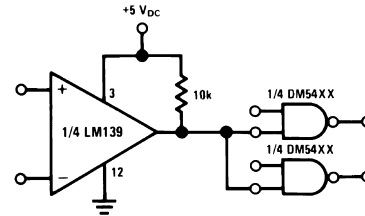


Figure 14. Driving TTL
($V^+ = 5.0 V_{DC}$)

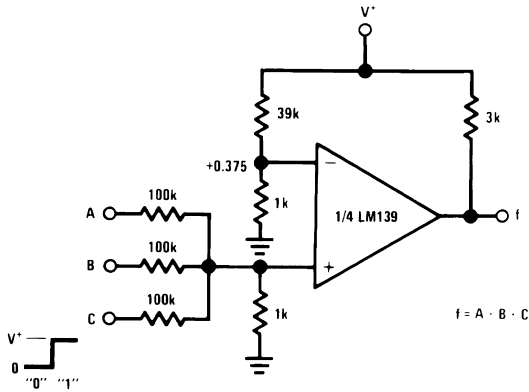


Figure 15. AND Gate
($V^+ = 5.0 V_{DC}$)

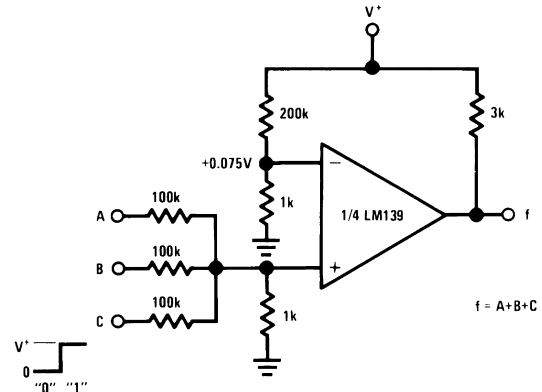


Figure 16. OR Gate
($V^+ = 5.0 V_{DC}$)

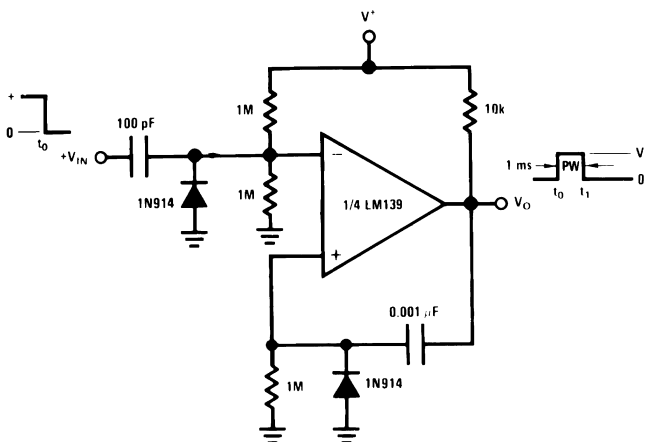


Figure 17. One-Shot Multivibrator
($V^+ = 15 V_{DC}$)

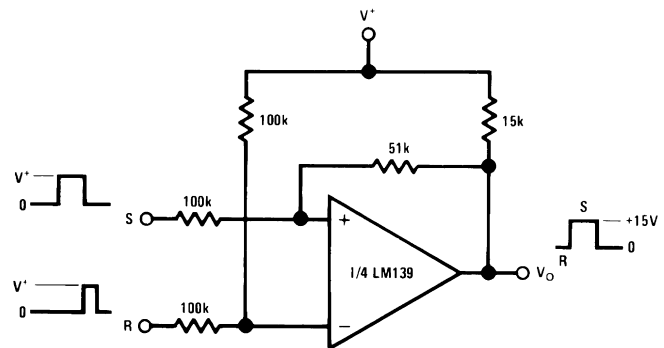


Figure 18. Bi-Stable Multivibrator
($V^+ = 15 V_{DC}$)

Typical Applications (continued)



Figure 19. One-Shot Multivibrator with Input Lock Out
($V^+ = 15 V_{DC}$)



Figure 20. Pulse Generator
($V^+ = 15 V_{DC}$)



Figure 21. Large Fan-In AND Gate
($V^+ = 15 V_{DC}$)



Figure 22. ORing the Outputs
($V^+ = 15 V_{DC}$)

Typical Applications (continued)

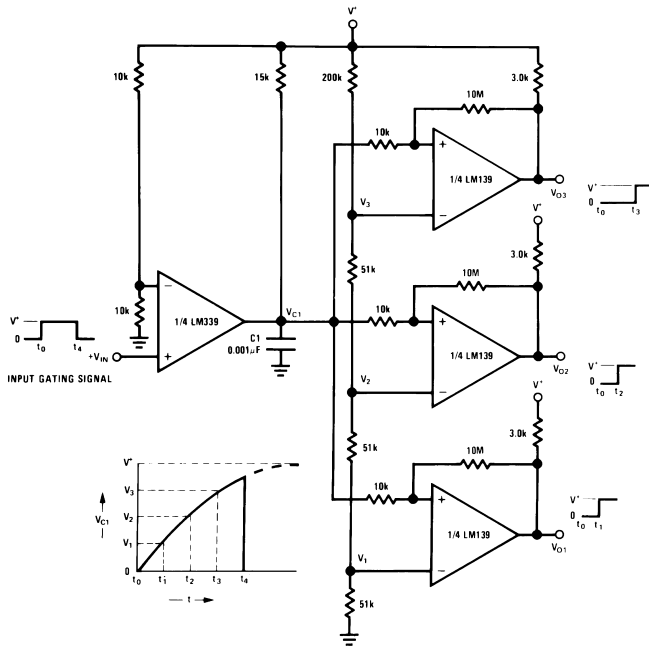


Figure 23. Time Delay Generator
($V^+ = 15 V_{DC}$)

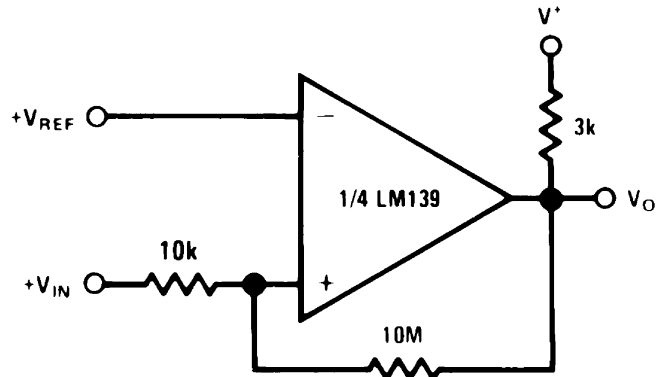


Figure 24. Non-Inverting Comparator with Hysteresis
($V^+ = 15 V_{DC}$)



Figure 25. Inverting Comparator With Hysteresis
($V^+ = 15 V_{DC}$)

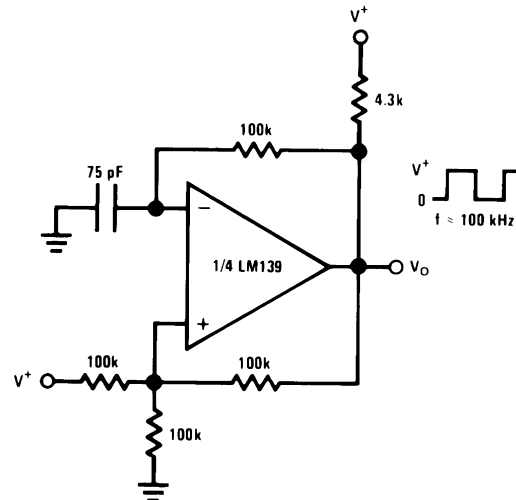


Figure 26. Squarewave Oscillator
($V^+ = 15 V_{DC}$)

Typical Applications (continued)

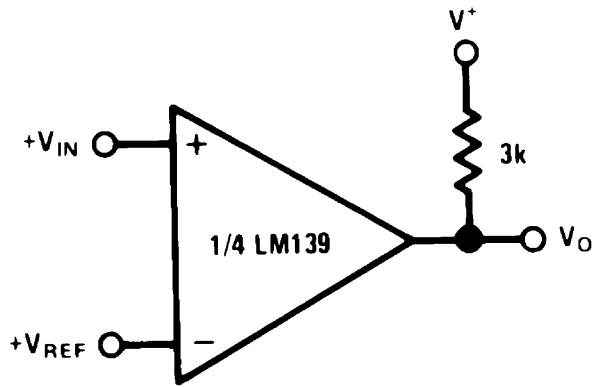


Figure 27. Basic Comparator
($V^+ = 15 V_{DC}$)

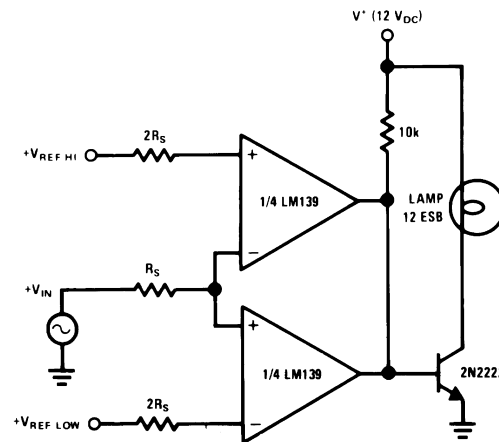


Figure 28. Limit Comparator
($V^+ = 15 V_{DC}$)

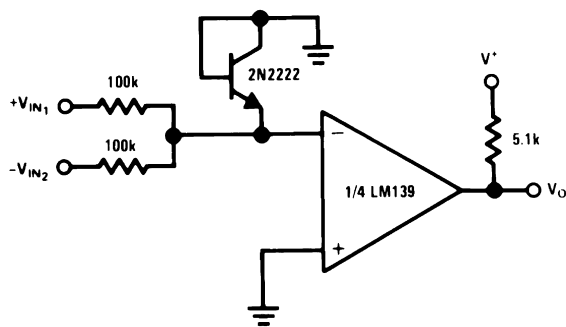


Figure 29. Comparing Input Voltages of Opposite Polarity
($V^+ = 15 V_{DC}$)

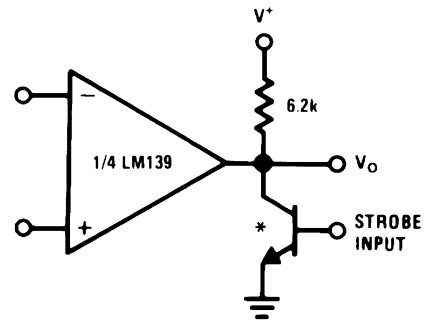


Figure 30. Output Strobing
($V^+ = 15 V_{DC}$)

* Or open-collector logic gate without pullup resistor

Typical Applications (continued)

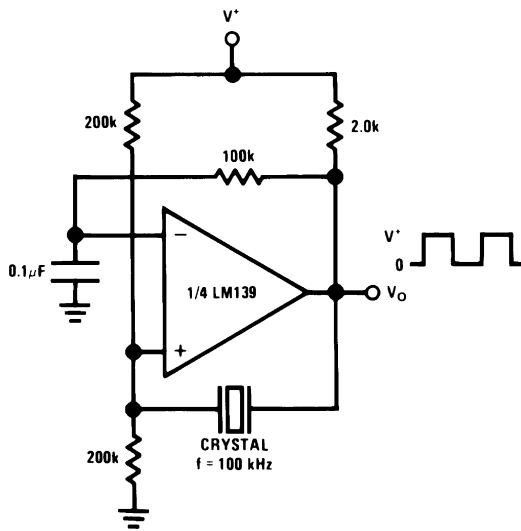
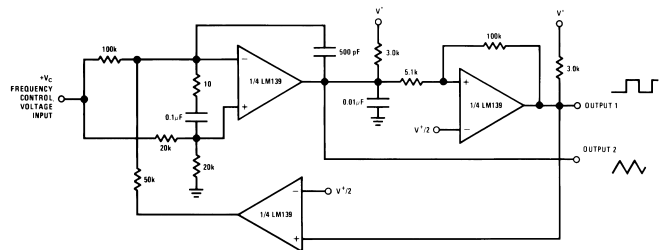


Figure 31. Crystal Controlled Oscillator
($V^+ = 15 V_{DC}$)



$250 \text{ mV}_{DC} \leq V_C \leq +50 V_{DC}$
 $700 \text{ Hz} \leq f_O \leq 100 \text{ kHz}$

Figure 32. Two-Decade High-Frequency VCO
 $V^+ = +30 V_{DC}$

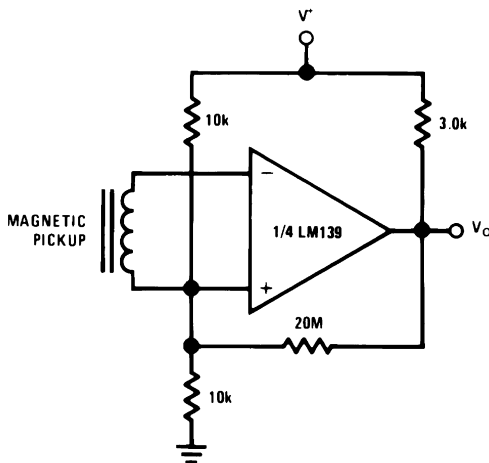


Figure 33. Transducer Amplifier
($V^+ = 15 V_{DC}$)

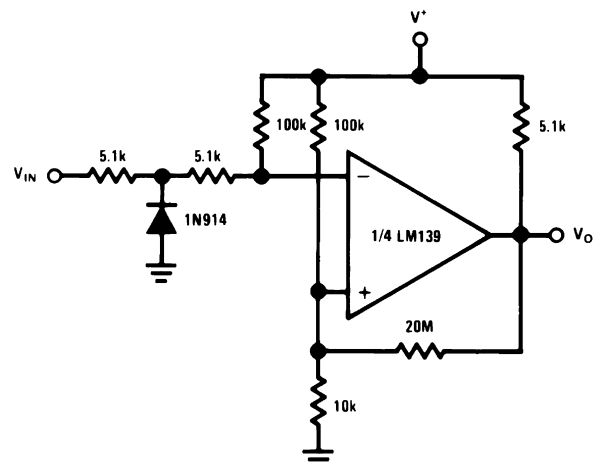


Figure 34. Zero Crossing Detector (Single Power Supply)
($V^+ = 15 V_{DC}$)

Typical Applications (continued)

8.2.2.1 Split-Supply Applications

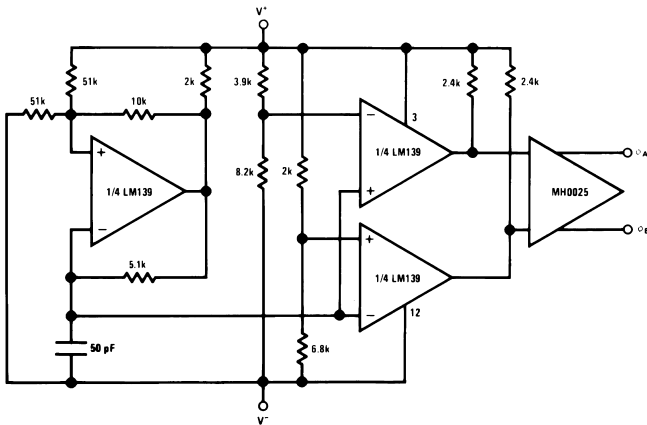


Figure 35. MOS Clock Driver
($V^+ = +15 V_{DC}$ and $V^- = -15 V_{DC}$)

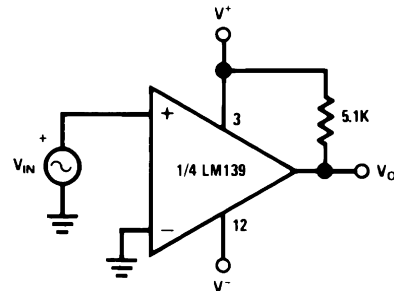


Figure 36. Zero Crossing Detector
($V^+ = +15 V_{DC}$ and $V^- = -15 V_{DC}$)

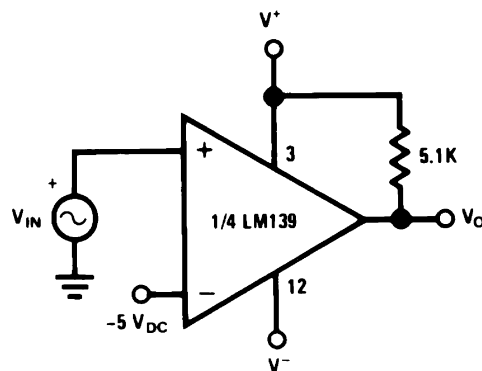


Figure 37. Comparator With a Negative Reference
($V^+ = +15 V_{DC}$ and $V^- = -15 V_{DC}$)

9 Power Supply Recommendations

Even in low-frequency applications, the LM139-N can have internal transients which are extremely quick. For this reason, bypassing the power supply with 1.0 μF to ground will provide improved performance; the supply bypass capacitor should be placed as close as possible to the supply pin and have a solid connection to ground. The bypass capacitors should have a low ESR.

10 Layout

10.1 Layout Guidelines

Try to minimize parasitic impedances on the inputs to avoid oscillation. Any positive feedback used as hysteresis should place the feedback components as close as possible to the input pins. Take care to ensure that the output pins do not couple to the inputs. This can occur through capacitive coupling if the traces are too close and lead to oscillations on the output.

The optimum bypass capacitor placement is closest to the V+ and ground pins. Take care to minimize the loop area formed by the bypass capacitor connection between V+ and ground. The ground pin should be connected to the PCB ground plane at the pin of the device. The feedback components should be placed as close to the device as possible minimizing strays.

10.2 Layout Example

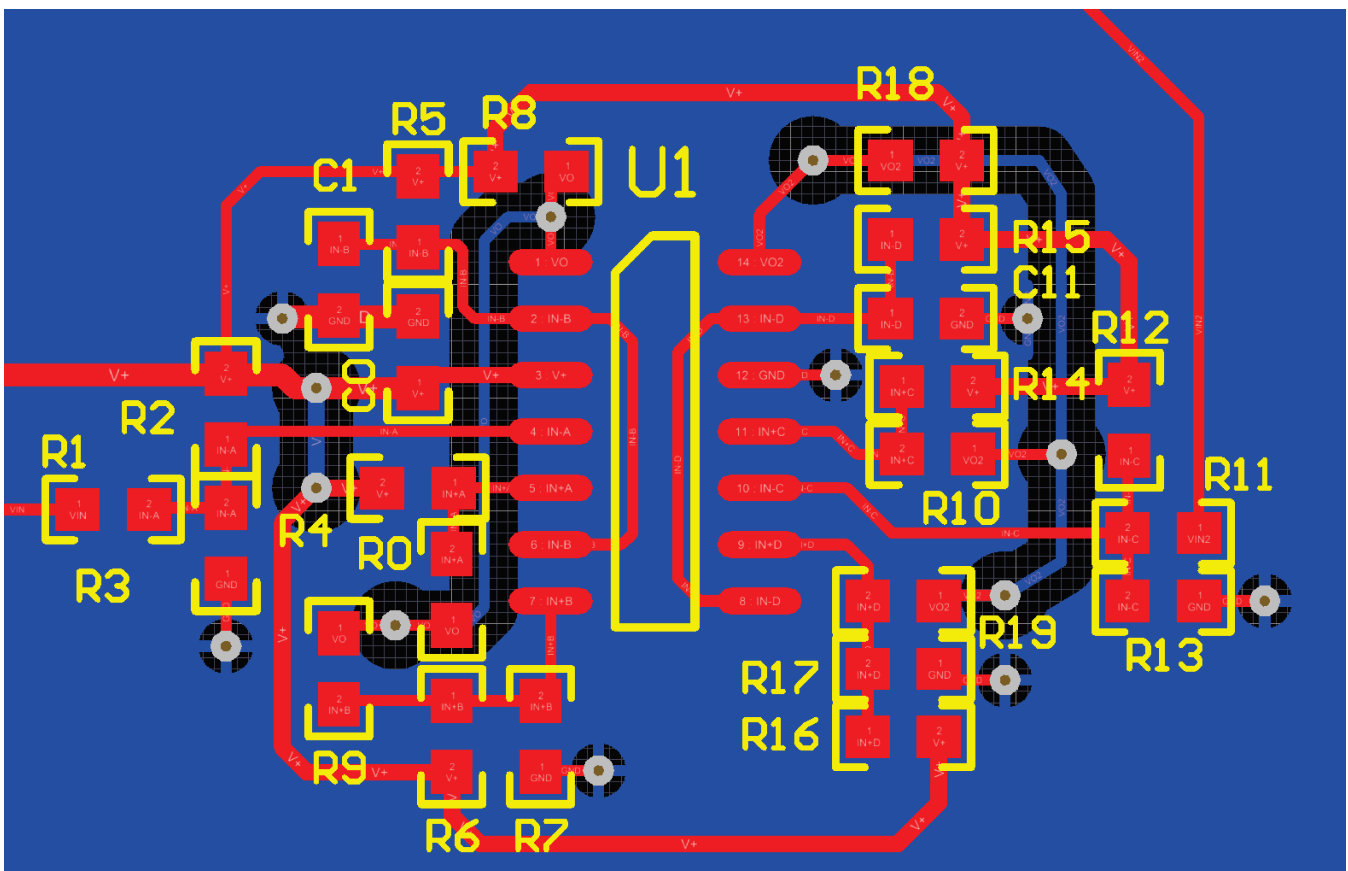


Figure 38. Layout Example

11 Device and Documentation Support

11.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|----------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| LM139-N | Click here | Click here | Click here | Click here | Click here |
| LM239-N | Click here | Click here | Click here | Click here | Click here |
| LM2901-N | Click here | Click here | Click here | Click here | Click here |
| LM3302-N | Click here | Click here | Click here | Click here | Click here |
| LM339-N | Click here | Click here | Click here | Click here | Click here |

11.2 Trademarks

All trademarks are the property of their respective owners.

11.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM139AJ/PB | ACTIVE | CDIP | J | 14 | 25 | TBD | Call TI | Call TI | -55 to 125 | LM139AJ | Samples |
| LM139J/PB | ACTIVE | CDIP | J | 14 | 25 | TBD | Call TI | Call TI | -55 to 125 | LM139J | Samples |
| LM239J | ACTIVE | CDIP | J | 14 | 25 | TBD | Call TI | Call TI | -25 to 85 | LM239J | Samples |
| LM2901M | ACTIVE | SOIC | D | 14 | 55 | TBD | Call TI | Call TI | -40 to 85 | LM2901M | Samples |
| LM2901M/NOPB | ACTIVE | SOIC | D | 14 | 55 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | LM2901M | Samples |
| LM2901MX | NRND | SOIC | D | 14 | 2500 | TBD | Call TI | Call TI | -40 to 85 | LM2901M | |
| LM2901MX/NOPB | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -40 to 85 | LM2901M | Samples |
| LM2901N/NOPB | ACTIVE | PDIP | NFF | 14 | 25 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | -40 to 85 | LM2901N | Samples |
| LM339AM | NRND | SOIC | D | 14 | 55 | TBD | Call TI | Call TI | -25 to 85 | LM339AM | |
| LM339AM/NOPB | ACTIVE | SOIC | D | 14 | 55 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -25 to 85 | LM339AM | Samples |
| LM339AMX | NRND | SOIC | D | 14 | 2500 | TBD | Call TI | Call TI | -25 to 85 | LM339AM | |
| LM339AMX/NOPB | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -25 to 85 | LM339AM | Samples |
| LM339AN/NOPB | ACTIVE | PDIP | NFF | 14 | 25 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | -25 to 85 | LM339AN | Samples |
| LM339J | ACTIVE | CDIP | J | 14 | 25 | TBD | Call TI | Call TI | -25 to 85 | LM339J | Samples |
| LM339M | NRND | SOIC | D | 14 | 55 | TBD | Call TI | Call TI | -25 to 85 | LM339M | |
| LM339M/NOPB | ACTIVE | SOIC | D | 14 | 55 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -25 to 85 | LM339M | Samples |
| LM339MX | NRND | SOIC | D | 14 | 2500 | TBD | Call TI | Call TI | -25 to 85 | LM339M | |
| LM339MX/NOPB | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-1-260C-UNLIM | -25 to 85 | LM339M | Samples |
| LM339N/NOPB | ACTIVE | PDIP | NFF | 14 | 25 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | -25 to 85 | LM339N | Samples |
| MLM339P | OBSOLETE | PDIP | NFF | 14 | | TBD | Call TI | Call TI | | LM339N | |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM2901MX | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |
| LM2901MX/NOPB | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |
| LM339AMX | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |
| LM339AMX/NOPB | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |
| LM339MX | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |
| LM339MX/NOPB | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.35 | 2.3 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM2901MX | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |
| LM2901MX/NOPB | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |
| LM339AMX | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |
| LM339AMX/NOPB | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |
| LM339MX | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |
| LM339MX/NOPB | SOIC | D | 14 | 2500 | 367.0 | 367.0 | 35.0 |

J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---------------|------------------------|------------------------|------------------------|------------------------|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package is hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

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Applications

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