

LP339

LP339 Ultra-Low Power Quad Comparator



Literature Number: SNOSBE0A

LP339

Ultra-Low Power Quad Comparator

General Description

The LP339 consists of four independent voltage comparators designed specifically to operate from a single power supply and draw typically 60 μA of power supply drain current over a wide range of power supply voltages. Operation from split supplies is also possible and the ultra-low power supply drain current is independent of the power supply voltage. These comparators also feature a common-mode range which includes ground, even when operated from a single supply.

Applications include limit comparators, simple analog-to-digital converters, pulse, square and time delay generators; VCO's; multivibrators; high voltage logic gates. The LP339 was specifically designed to interface with the CMOS logic family. The ultra-low supply current makes the LP339 valuable in battery powered applications.

- Single supply operation
- Sensing at ground
- Compatible with CMOS logic family
- Pin-out identical to LM339

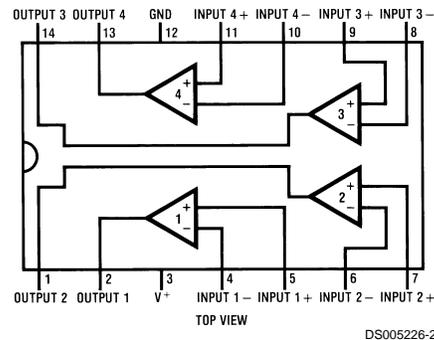
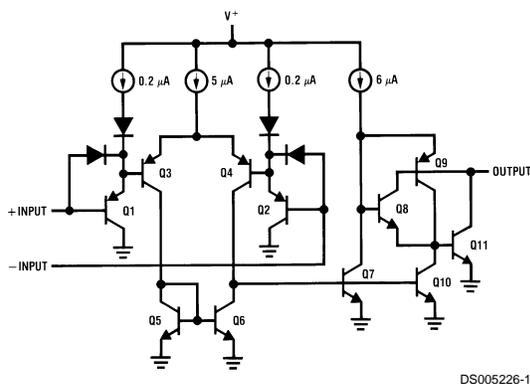
Features

- Ultra-low power supply current drain (60 μA)—independent of the supply voltage (75 μW /comparator at +5 V_{DC})
- Low input biasing current: 3 nA
- Low input offset current: ± 0.5 nA
- Low input offset voltage: ± 2 mV
- Input common-mode voltage includes ground
- Output voltage compatible with MOS and CMOS logic
- High output sink current capability (30 mA at $V_{\text{O}}=2 V_{\text{DC}}$)
- Supply Input protected against reverse voltages

Advantages

- Ultra-low power supply drain suitable for battery applications

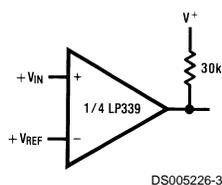
Schematic and Connection Diagrams



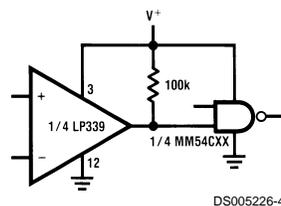
Order Number LP339M for S.O. Package
See NS Package Number M14A
Order Number LP339N for Dual-In-Line Package
See NS Package Number N14A

Typical Applications $(V^+= 5.0 V_{\text{DC}})$

Basic Comparator



Driving CMOS



Absolute Maximum Ratings (Note 1)

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

Supply Voltage	36 V _{DC} or ±18 V _{DC}
Differential Input Voltage	±36 V _{DC}
Input Voltage	-0.3 V _{DC} to 36 V _{DC}
Power Dissipation (Note 2)	
Molded DIP	570 mW
Output Short Circuit to GND (Note 3)	Continuous
Input Current V _{IN} < -0.3 V _{DC} (Note 4)	50 mA

Operating Temperature Range	0°C to +70°C
Storage Temperature Range	-65° to +150°C
Soldering Information:	
Dual-In-Line Package (10 sec.)	+260°C
S.O. Package:	
Vapor Phase (60 sec.)	+215°C
Infrared (15 sec.)	+220°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.	

Electrical Characteristics

(V₊=5 V_{DC}) (Note 5)

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage	T _A =25°C (Note 10)		±2	±5	mV _{DC}
Input Bias Current	I _{IN} (+) or I _{IN} (-) with the Output in the Linear Range, T _A =25°C (Note 6)		2.5	25	nA _{DC}
Input Offset Current	I _{IN} (+) - I _{IN} (-), T _A =25°C		±0.5	±5	nA _{DC}
Input Common Mode Voltage Range	T _A =25°C (Note 7)	0		V ₊ -1.5	V _{DC}
Supply Current	R _L =Infinite on all Comparators, T _A =25°C		60	100	μA _{DC}
Voltage Gain	V _O = 1 V _{DC} to 11 V _{DC} , R _L =15 kΩ, V ₊ =15 V _{DC} , T _A =25°C		500		V/mV
Large Signal Response Time	V _{IN} =TTL Logic Swing, V _{REF} =1.4 V _{DC} , V _{RL} =5 V _{DC} , R _L =5.1 kΩ, T _A =25°C		1.3		μSec
Response Time	V _{RL} =5 V _{DC} , R _L =5.1 kΩ, T _A =25°C (Note 8)		8		μSec
Output Sink Current	V _{IN} (-)=1 V _{DC} , V _{IN} (+)=0, V _O =2 V _{DC} , T _A =25°C (Note 12)	15	30		mA _{DC}
	V _O =0.4 V _{DC}	0.20	0.70		mA _{DC}
Output Leakage Current	V _{IN} (+)=1 V _{DC} , V _{IN} (-)=0, V _O =5 V _{DC} , T _A =25°C		0.1		nA _{DC}
Input Offset Voltage	(Note 10)			±9	mV _{DC}
Input Offset Current	I _{IN} (+) - I _{IN} (-)		±1	±15	nA _{DC}
Input Bias Current	I _{IN} (+) or I _{IN} (-) with Output in Linear Range		4	40	nA _{DC}
Input Common Mode Voltage Range	Single Supply	0		V ₊ -2.0	V _{DC}
Output Sink Current	V _{IN} (-)=1 V _{DC} , V _{IN} (+)=0, V _O =2 V _{DC}	10			mA _{DC}
Output Leakage Current	V _{IN} (+)=1 V _{DC} , V _{IN} (-)=0, V _O =30 V _{DC}			1.0	μA _{DC}
Differential Input Voltage	All V _{IN} 's ≥ 0 V _{DC} (or V ₋ on split supplies) (Note 9)			36	V _{DC}

Note 1: 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 2: For elevated temperature operation, T_J max is 125°C for the LP339. θ_{JA} (junction to ambient) is 175°C/W for the LP339N and 120°C/W for the LP339M when either device is soldered in a printed circuit board in a still air environment. 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.

Note 3: Short circuits from the output to V₊ can cause excessive heating and eventual destruction. The maximum output current is approximately 50 mA.

Note 4: 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 clamp diodes. 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 voltage of the comparators to go to the V₊ voltage level (or to ground for a large input 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 is negative, again returns to a value greater than -0.3 V_{DC} (T_A=25°C).

Note 5: These specifications apply for V₊=5V_{DC} and 0°C ≤ T_A ≤ 70°C, unless otherwise stated. The temperature extremes are guaranteed but not 100% production tested. These parameters are not used to calculate outgoing AQL.

Note 6: 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 the input lines as long as the common-mode range is not exceeded.

Note 7: The input common-mode voltage or either input voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V₊-1.5V (T_A=25°C), but either or both inputs can go to 30 V_{DC} without damage.

Note 8: The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 1.3 μs can be obtained. See Typical Performance Characteristics section.

Electrical Characteristics (Continued)

Note 9: 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 $T_A=25^\circ\text{C}$.

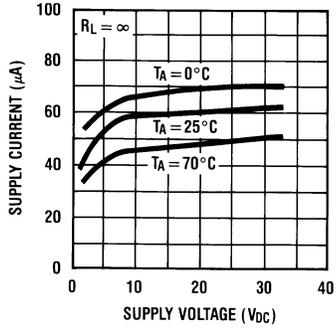
Note 10: At output switch point, $V_O=1.4\text{V}$, $R_S=0\Omega$ with V^+ from $5 V_{DC}$; and over the full input common-mode range ($0 V_{DC}$ to $V^+-1.5 V_{DC}$).

Note 11: For input signals that exceed V^+ , only the overdriven comparator is affected. With a 5V supply, V_{IN} should be limited to 25V maximum, and a limiting resistor should be used on all inputs that might exceed the positive supply.

Note 12: The output sink current is a function of the output voltage. The LP339 has a bi-modal output section which allows it to sink large currents via a Darlington connection at output voltages greater than approximately $1.5 V_{DC}$ and sink lower currents below this point. (See typical characteristics section and applications section).

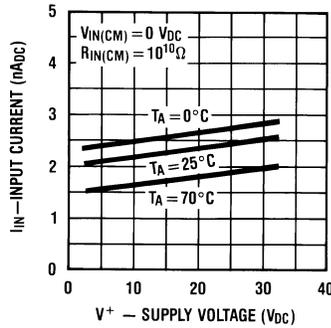
Typical Performance Characteristics

Supply Current



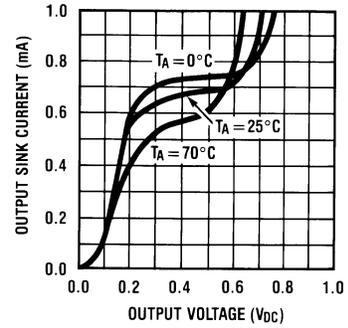
DS005226-35

Input Current



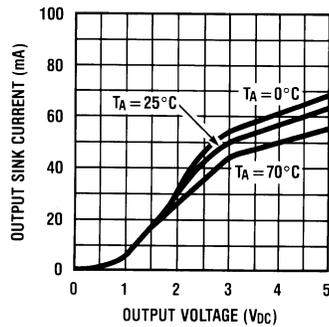
DS005226-36

Output Sink Current



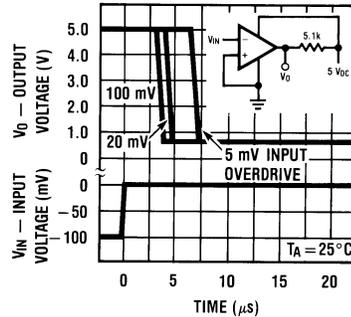
DS005226-37

Output Sink Current



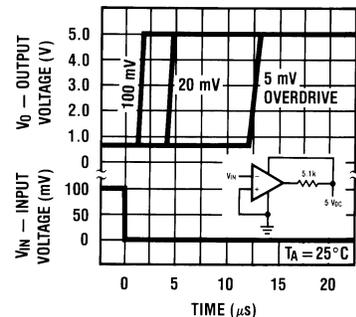
DS005226-38

Response Times for Various Input Overdrives — Negative Transition



DS005226-39

Response Times for Various Input Overdrives — Positive Transition



DS005226-40

Application Hints

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

The bias network of the LP339 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from $2 V_{DC}$ to $30 V_{DC}$.

It is usually unnecessary to use a bypass capacitor across the power supply line.

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 application section.

The output section of the LP339 has two distinct modes of operation—a Darlington mode and a grounded emitter mode. This unique drive circuit permits the LP339 to sink 30 mA at $V_O=2 V_{DC}$ (Darlington mode) and $700 \mu\text{A}$ at $V_O=0.4 V_{DC}$ (grounded emitter mode). *Figure 1* is a simplified schematic diagram of the LP339 output section.

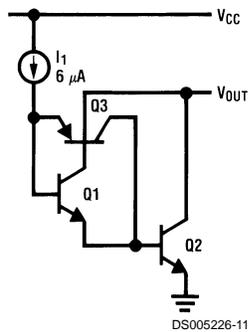


FIGURE 1.

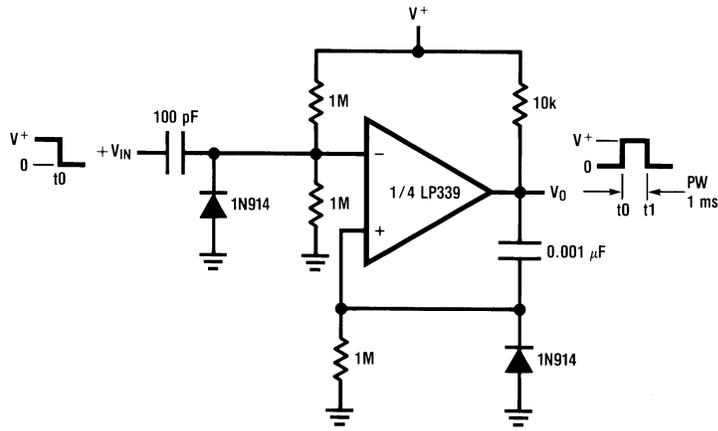
Notice that the output section is configured in a Darlington connection (ignoring Q3). Therefore, if the output voltage is held high enough ($V_O \geq 1 V_{DC}$), Q1 is not saturated and the output current is limited only by the product of the betas of Q1, Q2 and I1 (and the $60\Omega R_{SAT}$ of Q2). The LP339 is thus capable of driving LED's, relays, etc. in this mode while maintaining an ultra-low power supply current of typically $60 \mu\text{A}$.

If transistor Q3 were omitted, and the output voltage allowed to drop below about $0.8 V_{DC}$, transistor Q1 would saturate and the output current would drop to zero. The circuit would, therefore, be unable to "pull" low current loads down to ground (or the negative supply, if used). Transistor Q3 has been included to bypass transistor Q1 under these conditions and apply the current I1 directly to the base of Q2. The output sink current is now approximately I1 times the beta of Q2 ($700 \mu\text{A}$ at $V_O=0.4 V_{DC}$). The output of the LP339 exhibits a bi-modal characteristic with a smooth transition between modes. (See Output Sink Current graphs in Typical Performance Characteristics section.)

It is also important to note that in both cases the output is an uncommitted collector. Therefore, many collectors can be tied together to provide an output OR'ing function. An output pull-up resistor can be connected to any available power supply voltage within the permitted power 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 LP339 package.

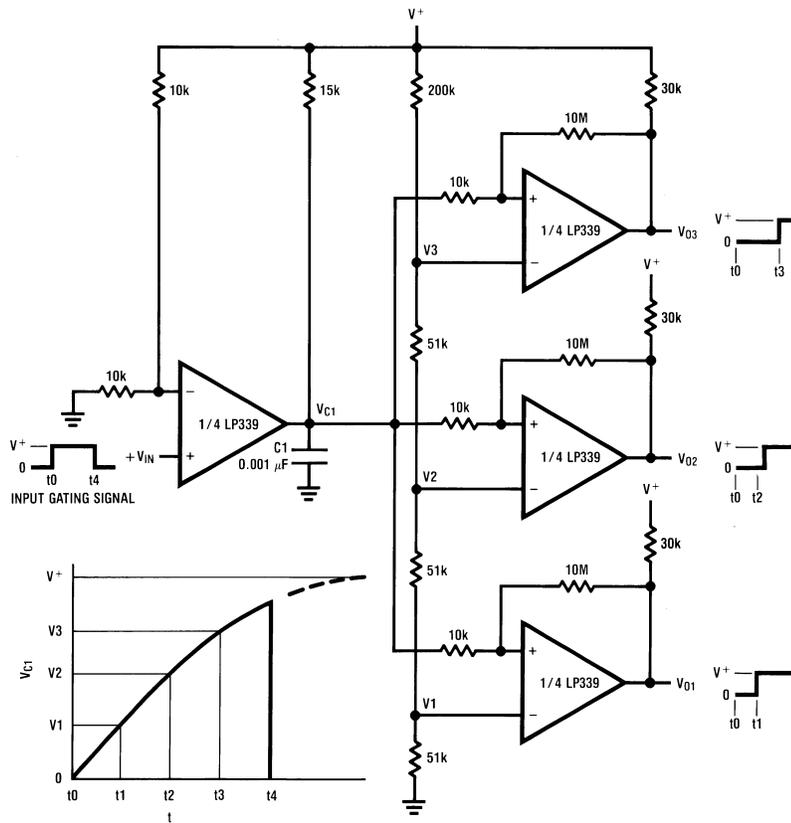
Typical Applications ($V^+=15\text{ V}_{DC}$)

One-Shot Multivibrator



DS005226-13

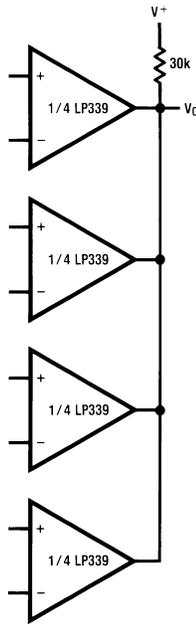
Time-Delay Generator



DS005226-15

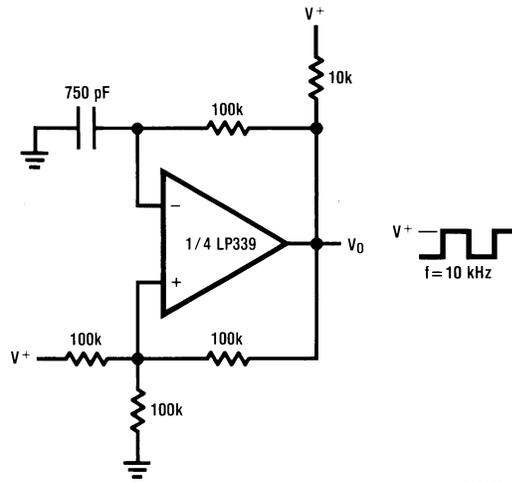
Typical Applications ($V^+=15\text{ V}_{DC}$) (Continued)

ORing the Outputs



DS005226-16

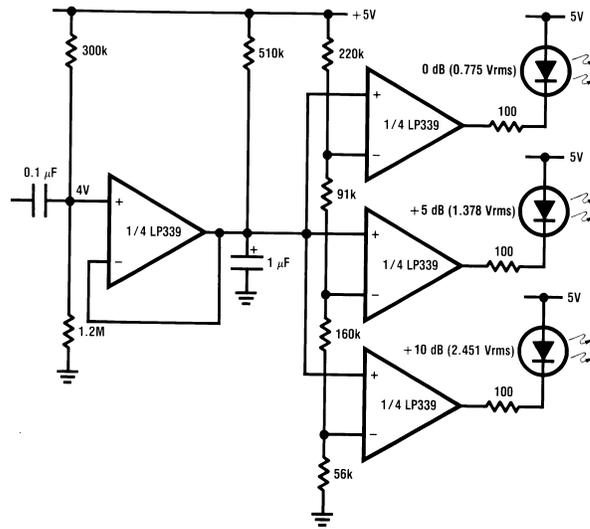
Squarewave Oscillator



DS005226-17

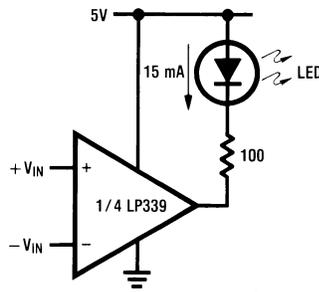
Typical Applications ($V^+=15\text{ V}_{DC}$) (Continued)

Three Level Audio Peak Indicator



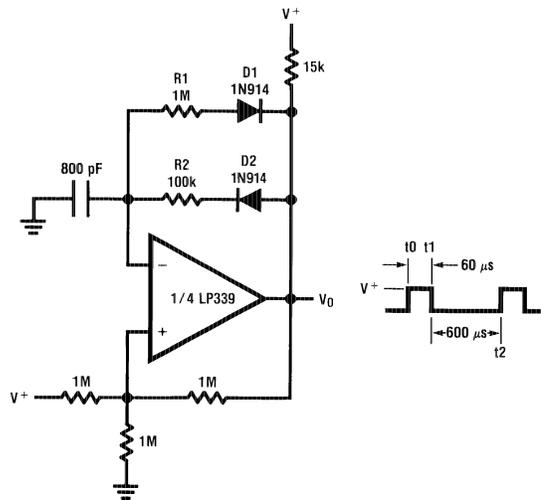
DS005226-19

LED Driver



DS005226-22

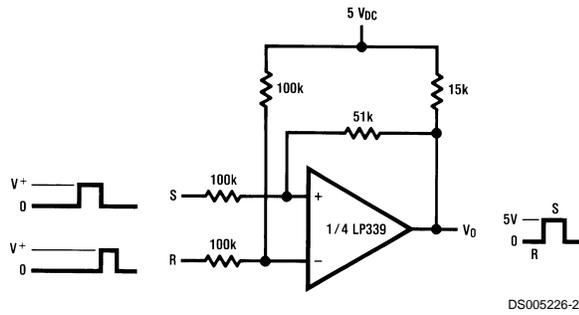
Pulse Generator



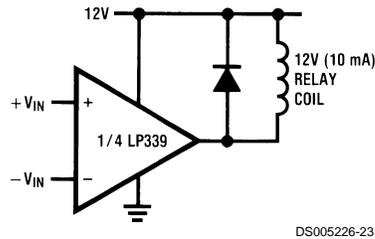
DS005226-18

Typical Applications ($V^+=15\text{ V}_{DC}$) (Continued)

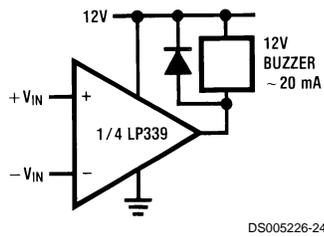
Bi-Stable Multivibrator



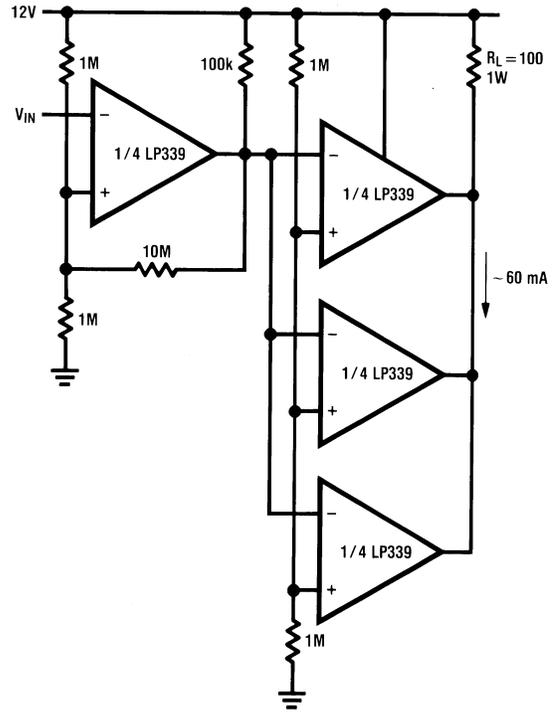
Relay Driver



Buzzer Driver

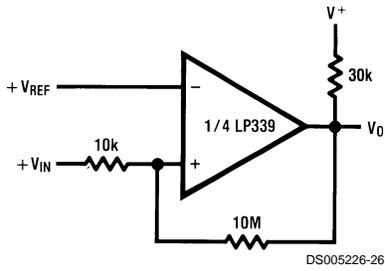


Comparator With 60 mA Sink Capability



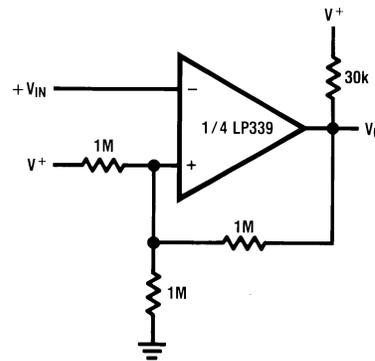
Typical Applications ($V^+=15\text{ V}_{DC}$) (Continued)

Non-Inverting Comparator with Hysteresis



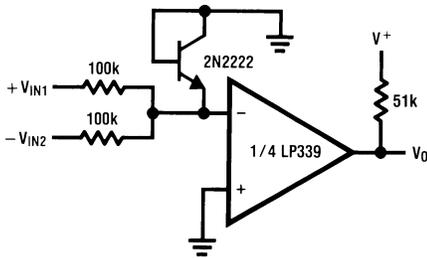
DS005226-26

Inverting Comparator with Hysteresis



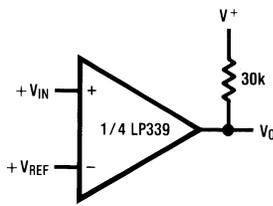
DS005226-27

Comparing Input Voltages of Opposite Polarity



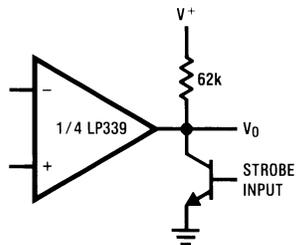
DS005226-28

Basic Comparator



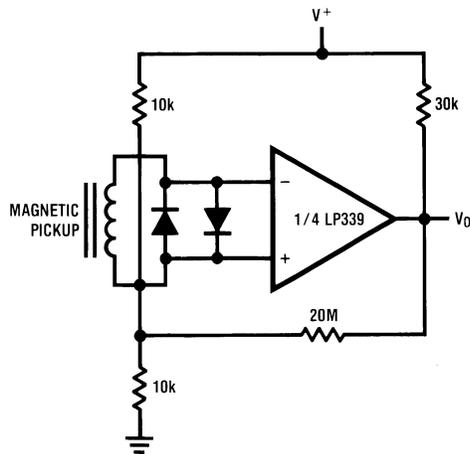
DS005226-29

Output Strobing



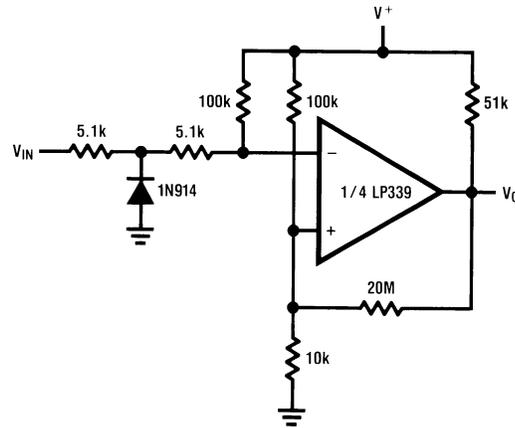
DS005226-30

Transducer Amplifier



DS005226-31

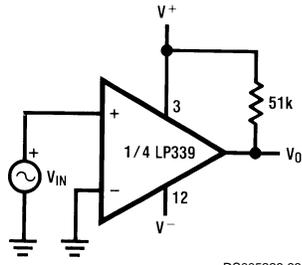
Zero Crossing Detector (Single Power Supply)



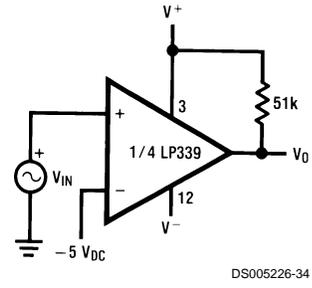
DS005226-32

Typical Applications ($V^+=15\text{ V}_{DC}$) (Continued)

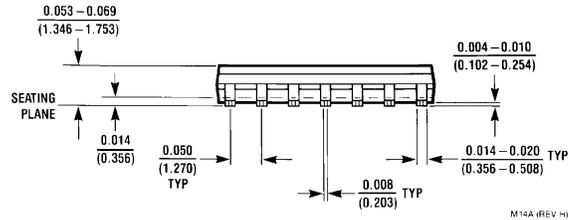
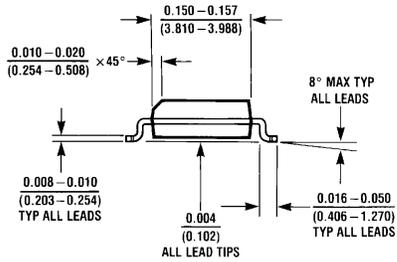
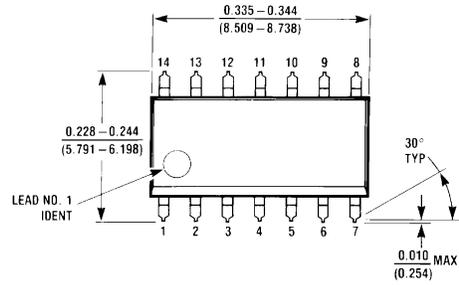
**Split-Supply Applications
Zero Crossing Detector**



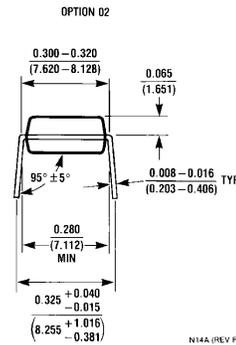
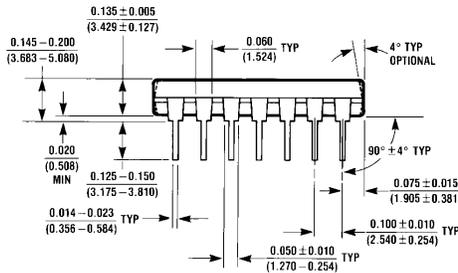
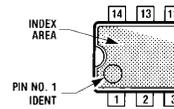
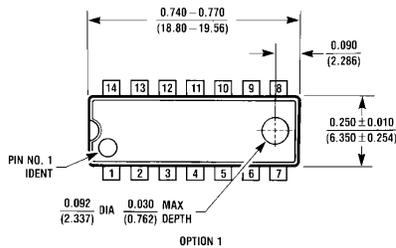
Comparator With a Negative Reference



Physical Dimensions inches (millimeters) unless otherwise noted



S.O. Package (M)
Order Number LP339M or LP339MX
NS Package M14A



Molded Dual-In-Line Package (N)
Order Number LP339N
NS Package Number N14A

Notes

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.

 <p>National Semiconductor Corporation Americas Tel: 1-800-272-9959 Fax: 1-800-737-7018 Email: support@nsc.com www.national.com</p>	<p>National Semiconductor Europe Fax: +49 (0) 180-530 85 86 Email: europe.support@nsc.com Deutsch Tel: +49 (0) 69 9508 6208 English Tel: +44 (0) 870 24 0 2171 Français Tel: +33 (0) 1 41 91 8790</p>	<p>National Semiconductor Asia Pacific Customer Response Group Tel: 65-2544466 Fax: 65-2504466 Email: ap.support@nsc.com</p>	<p>National Semiconductor Japan Ltd. Tel: 81-3-5639-7560 Fax: 81-3-5639-7507</p>
---	--	---	---

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Mobile Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated