

## LM139JAN Low Power Low Offset Voltage Quad Comparators

Check for Samples: [LM139JAN](#)

### FEATURES

- Wide supply voltage range 5V to 36 V<sub>DC</sub> or  $\pm 2.5\text{V}$  to  $\pm 18\text{V}_{\text{DC}}$
- Very low supply current drain (0.8 mA) - independent of supply voltage
- Low input biasing current: 25 nA
- Low input offset current:  $\pm 5\text{ nA}$
- Offset voltage:  $\pm 3\text{ mV}$
- Input common-mode voltage range includes GND
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage: 250 mV at 4 mA

- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

### ADVANTAGES

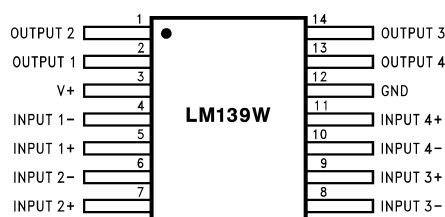
- High precision comparators
- Reduced V<sub>OS</sub> drift over temperature
- Eliminates need for dual supplies
- Allows sensing near GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

### DESCRIPTION

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

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

### Connection Diagrams



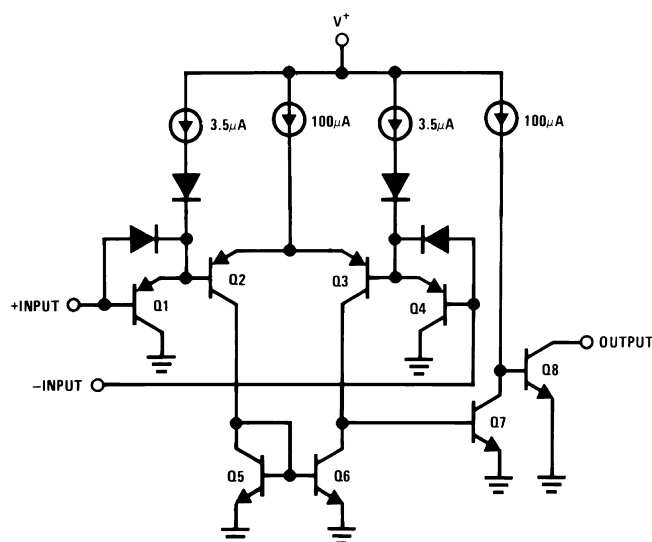
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 2005–2010, Texas Instruments Incorporated

## Schematic Diagram



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.

## Absolute Maximum Ratings <sup>(1)</sup>

Supply Voltage, $V^{+}$ <sup>(2)</sup>	36 $V_{DC}$ or $\pm 18 V_{DC}$
Differential Input Voltage <sup>(3)</sup>	36 $V_{DC}$
Output Voltage	36 $V_{DC}$
Input Voltage	$-0.3 V_{DC}$ to $+36 V_{DC}$
Input Current ( $V_{IN} < -0.3 V_{DC}$ ) <sup>(4)(5)</sup>	50 mA
Power Dissipation <sup>(6) (7)</sup>	
CERPACK	350 mW @ $T_A = 125^{\circ}C$
Output Short-Circuit to GND, <sup>(8)</sup>	Continuous
Storage Temperature Range	$-65^{\circ}C \leq T_A \leq +150^{\circ}C$
Maximum Junction Temperature ( $T_J$ )	$+175^{\circ}C$
Lead Temperature (Soldering, 10 seconds)	$260^{\circ}C$
Operating Temperature Range	$-55^{\circ}C \leq T_A \leq +125^{\circ}C$
Thermal Resistance	
$\theta_{JA}$	
CERPACK (Still Air)	183°C/W
CERPACK (500LF / Min Air flow)	120°C/W
$\theta_{JC}$	
CERPACK	23°C/W
Package Weight (typical)	
CERPACK	460mg
ESD rating <sup>(9)</sup>	600V

- (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. 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.
- (2) Short circuits from the output to  $V^{+}$  can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 20mA independent of the magnitude of  $V^{+}$ .
- (3) 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  $25^{\circ}C$ ).
- (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 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  $25^{\circ}C$ ).
- (5) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
- (6) The low bias dissipation and the ON-OFF characteristics of the outputs keeps the chip dissipation very small ( $P_D \leq 100mW$ ), provided the output transistors are allowed to saturate.
- (7) 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.
- (8) 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  $V^{+}$ .
- (9) Human Body model, 1.5 K $\Omega$  in series with 100 pF

## Quality Conformance Inspection

Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp ( $^{\circ}C$ )
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

Subgroup	Description	Temp (°C)
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

## LM139 JAN Electrical Characteristics DC Parameters

The following conditions apply, unless otherwise specified.  $-V_{CC} = 0V$

Symbol	Parameters	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_{IO}$	Input Offset Voltage	$+V_{CC} = 30V, V_O = 15V$		-5.0	5.0	mV	1
				-7.0	7.0	mV	2, 3
		$+V_{CC} = 2V, -V_{CC} = -28V, V_O = -13V$		-5.0	5.0	mV	1
				-7.0	7.0	mV	2, 3
		$+V_{CC} = 5V, V_O = 1.4V$		-5.0	5.0	mV	1
				-7.0	7.0	mV	2, 3
		$+V_{CC} = 2V, -V_{CC} = -3V, V_O = -1.6V$		-5.0	5.0	mV	1
				-7.0	7.0	mV	2, 3
$I_{IO}$	Input Offset Current	$+V_{CC} = 30V, R_S = 20K\Omega, V_O = 15V$	(1)	-25	25	nA	1, 2
			(1)	-75	75	nA	3
		$+V_{CC} = 2V, -V_{CC} = -28V, R_S = 20K\Omega, V_O = -13V$	(1)	-25	25	nA	1, 2
			(1)	-75	75	nA	3
		$+V_{CC} = 5V, R_S = 20K\Omega, V_O = 1.4V$	(1)	-25	25	nA	1, 2
			(1)	-75	75	nA	3
		$+V_{CC} = 2V, -V_{CC} = -3V, R_S = 20K\Omega, V_O = -1.6V$	(1)	-25	25	nA	1, 2
			(1)	-75	75	nA	3
$\pm I_{IB}$	Input Bias Current	$+V_{CC} = 30V, R_S = 20K\Omega, V_O = 15V$	(1)	-100	+0.1	nA	1, 2
			(1)	-200	+0.1	nA	3
		$+V_{CC} = 2V, -V_{CC} = -28V, R_S = 20K\Omega, V_O = -13V$	(1)	-100	+0.1	nA	1, 2
			(1)	-200	+0.1	nA	3
		$+V_{CC} = 5V, R_S = 20K\Omega, V_O = 1.4V$	(1)	-100	+0.1	nA	1, 2
			(1)	-200	+0.1	nA	3
		$+V_{CC} = 2V, -V_{CC} = -3V, R_S = 20K\Omega, V_O = -1.6V$	(1)	-100	+0.1	nA	1, 2
			(1)	-200	+0.1	nA	3
CMRR	Input Voltage Common Mode Rejection	$+V_{CC} = 30V$		76		dB	1, 2, 3
		$+V_{CC} = 5V$		70		dB	1, 2, 3
$I_{CEX}$	Output Leakage	$+V_{CC} = 30V, V_O = +30V$			1.0	$\mu A$	1, 2, 3
$+I_{IL}$	Input Leakage Current	$+V_{CC} = 36V, V + i = 34V, V - i = 0V$		-500	500	nA	1, 2, 3
$-I_{IL}$	Input Leakage Current	$+V_{CC} = 36V, V + i = 0V, V - i = 34V$		-500	500	nA	1, 2, 3
$V_{OL}$	Logical "0" Output Voltage	$+V_{CC} = 4.5V, I_O = 4mA$			0.4	V	1
					0.7	V	2, 3
		$+V_{CC} = 4.5V, I_O = 8mA$			1.5	V	1
					2.0	V	2, 3
$I_{CC}$	Power Supply Current	$+V_{CC} = 5V, V_{ID} = 15mV$			2.0	mA	1, 2
					3.0	mA	3
		$+V_{CC} = 30V, V_{ID} = 15mV$			3.0	mA	1, 2
					4.0	mA	3
$\Delta V_{IO} / \Delta T$	Temperature Coefficient of Input Offset Voltage	$25^\circ C \leq T_A \leq 125^\circ C$	(2)	-25	25	$\mu V/^\circ C$	2
		$-55^\circ C \leq T_A \leq 25^\circ C$	(2)	-25	25	$\mu V/^\circ C$	3
$\Delta I_{IO} / \Delta T$	Temperature Coefficient of Input Offset Current	$25^\circ C \leq T_A \leq 125^\circ C$	(2)	-300	300	$pA/^\circ C$	2
		$-55^\circ C \leq T_A \leq 25^\circ C$	(2)	-400	400	$pA/^\circ C$	3

(1) S/S  $R_S = 20K\Omega$ , tested at  $R_S = 10K\Omega$  as equivalent test.

(2) Calculated parameter; for Delta  $V_{IO}$  / Delta T use  $V_{IO}$  test at  $+V_{CC} = 30V, -V_{CC} = 0V, V_O = 15V$ ; and for Delta  $I_{IO}$  / Delta T use  $I_{IB}$  test at  $+V_{CC} = 30V, -V_{CC} = 0V, V_O = 15V$

## LM139 JAN Electrical Characteristics DC Parameters (continued)

The following conditions apply, unless otherwise specified.  $-V_{CC} = 0V$

Symbol	Parameters	Conditions	Notes	Min	Max	Unit	Sub-groups
$A_{VS}$	Open Loop Voltage Gain	$+V_{CC} = 15V$ , $R_L = 15K\Omega$ , $1V \leq V_O \leq 11V$	(3)	50		V/mV	4
			(3)	25		V/mV	5, 6
$V_{IO}$	Tempco Screen				4.0	mV	
CMRR	Tempco Screen				70	dB	
$I_{IO}$	Tempco Screen				13	nA	
$I_{IB}$	Tempco Screen				12	nA	

(3) Datalog of  $K = V/mV$ .

**LM139 JAN Electrical Characteristics AC Parameters**

Symbol	Parameters	Conditions	Notes	Min	Max	Unit	Sub-groups
$t_{RLH}$	Response Time: Low-to-High	$+V_{CC} = 5V, V_I = 100mV, R_L = 5.1K\Omega, V_{OD} = 5mV$			5.0	$\mu S$	7, 8B
					7.0	$\mu S$	8A
		$+V_{CC} = 5V, V_I = 100mV, R_L = 5.1K\Omega, V_{OD} = 50mV$			0.8	$\mu S$	7, 8B
					1.2	$\mu S$	8A
$t_{RHL}$	Response Time: High-to-Low	$+V_{CC} = 5V, V_I = 100mV, R_L = 5.1K\Omega, V_{OD} = 5mV$			2.5	$\mu S$	7, 8B
					3.0	$\mu S$	8A
		$+V_{CC} = 5V, V_I = 100mV, R_L = 5.1K\Omega, V_{OD} = 50mV$			0.8	$\mu S$	7, 8B
					1.0	$\mu S$	8A
$C_S$	Channel Separation	$+V_{CC} = 20V, -V_{CC} = -10V, A \text{ to } B$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, A \text{ to } C$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, A \text{ to } D$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, B \text{ to } A$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, B \text{ to } C$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, B \text{ to } D$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, C \text{ to } A$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, C \text{ to } B$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, C \text{ to } D$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, D \text{ to } A$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, D \text{ to } B$		80		dB	7
		$+V_{CC} = 20V, -V_{CC} = -10V, D \text{ to } C$		80		dB	7
$V_{LAT}$	Voltage Latch (Logical "1" Input)	$+V_{CC} = 5V, V_I = 10V, I_O = 4mA$			0.4	V	9

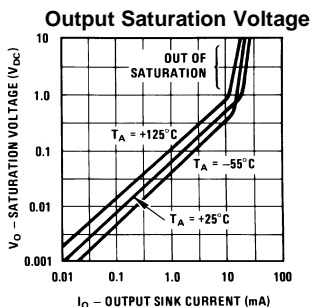
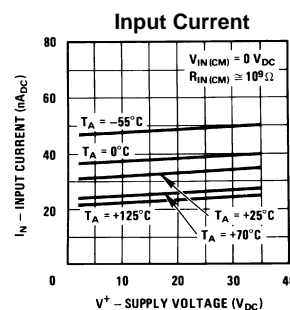
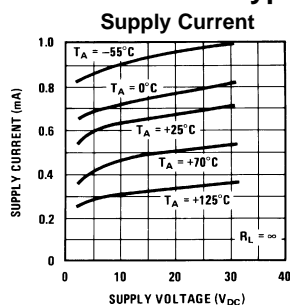
**LM139 JAN Electrical Characteristics DC Parameters Drift Values**

The following conditions apply, unless otherwise specified.  $-V_{CC} = 0V$   
 Delta calculations performed on JAN S product at Group B, Subgroup 5.

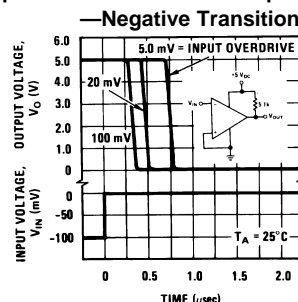
Symbol	Parameters	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_{IO}$	Input Offset Voltage	$V_{CC} = 30V, V_O = 15V$		-1.0	1.0	mV	1
$\pm I_{Bias}$	Input Bias Current	$V_{CC} = 30V, R_S = 20K\Omega, V_O = 15V$		-15	15	nA	1



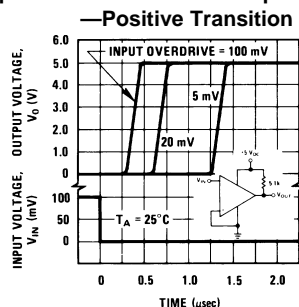
## Typical Performance Characteristics



### Response Time for Various Input Overdrives



### Response Time for Various Input Overdrives



## Application Hints

The LM139 is a high gain, wide bandwidth device which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs via stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Power supply bypassing is not required to solve this problem. Standard PC board layout is helpful as it reduces stray input-output coupling. Reducing 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.

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

The bias network of the LM139 establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from  $5 V_{DC}$  to  $30 V_{DC}$ .

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

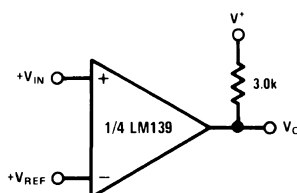
The differential input voltage may be larger than  $V^+$  without damaging the device. Protection should be provided to prevent the input voltages from going negative more than  $-0.3 V_{DC}$  (at  $25^\circ\text{C}$ ). An input clamp diode can be used as shown in the applications section.

The output of the LM139 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 pull-up 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 LM139 package. The output can also be used as a simple SPST switch to ground (when a pull-up resistor is not used). The amount of current which the output device can sink is limited by the drive available (which is independent of  $V^+$ ) and the  $\beta$  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  $60\Omega$   $R_{SAT}$  of the output transistor. The low offset voltage of the output transistor (1 mV) allows the output to clamp essentially to ground level for small load currents.

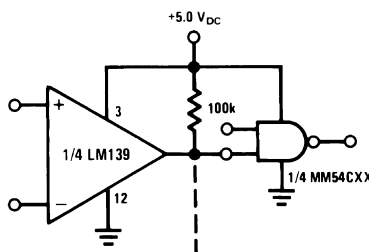
## Typical Applications

( $V^+ = 5.0\text{ V}_{DC}$ )

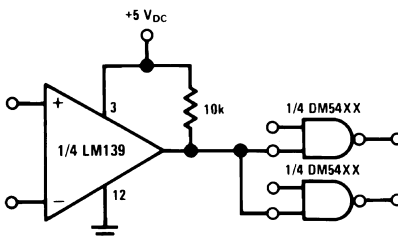
**Figure 1. Basic Comparator**



**Figure 2. Driving CMOS**

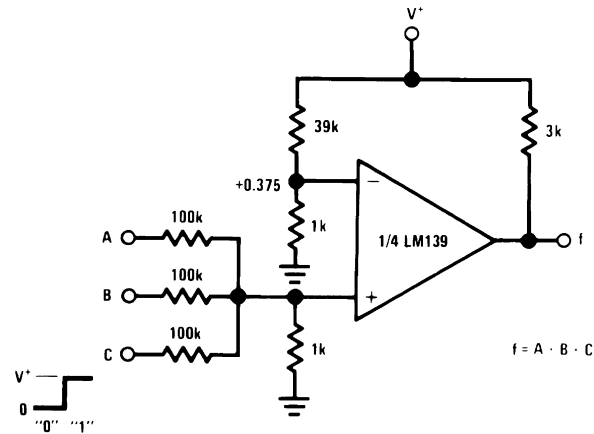


**Figure 3. Driving TTL**

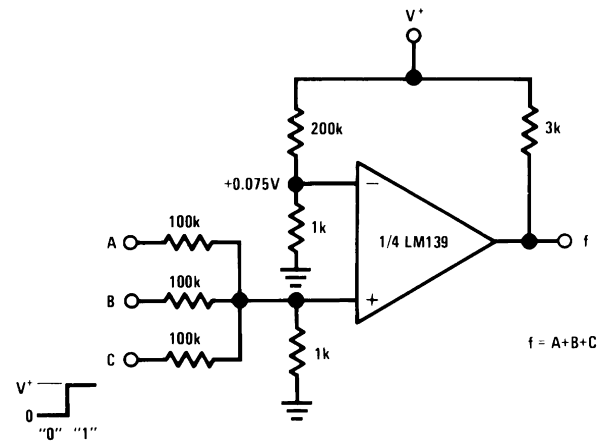


( $V^+ = 5.0\text{ V}_{\text{DC}}$ )

**Figure 4. AND Gate**

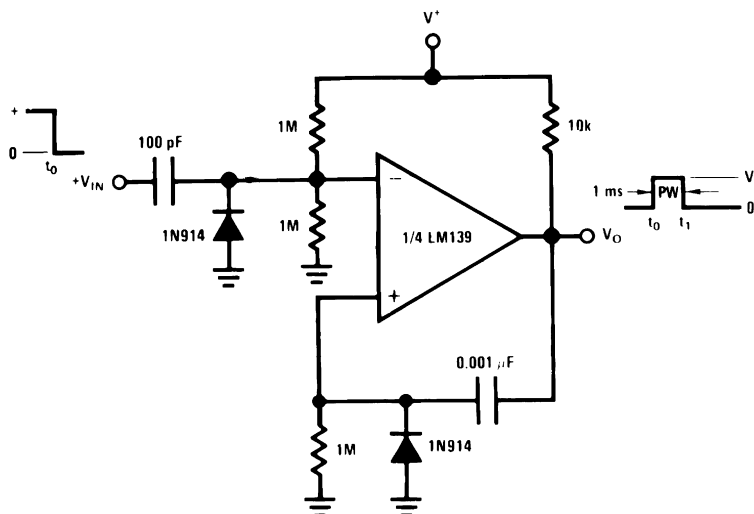
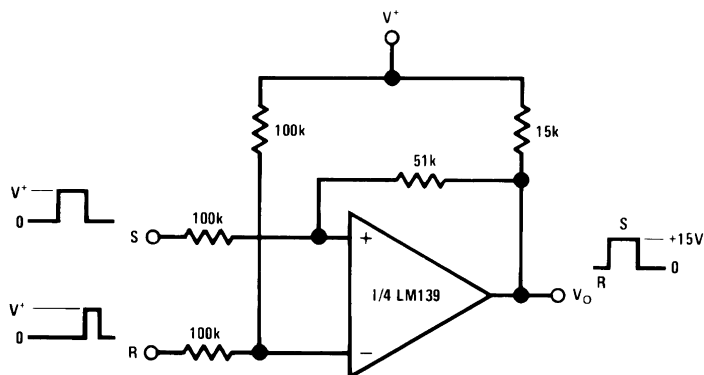
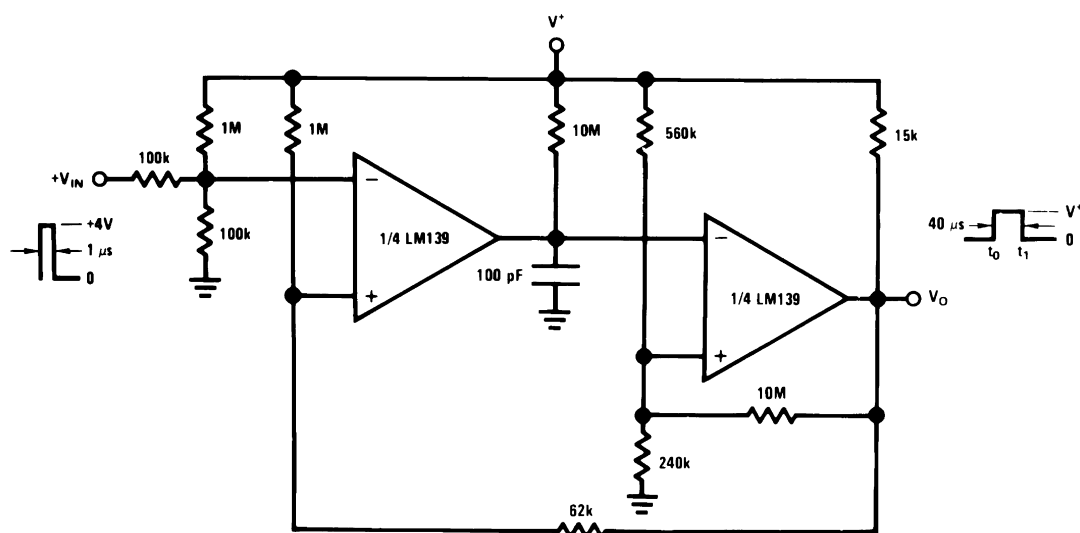


**Figure 5. OR Gate**



## Typical Applications

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

(V<sup>+</sup> = 15 V<sub>DC</sub>)**Figure 6. One-Shot Multivibrator****Figure 7. Bi-Stable Multivibrator****Figure 8. One-Shot Multivibrator with Input Lock Out**

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

Figure 9. Pulse Generator

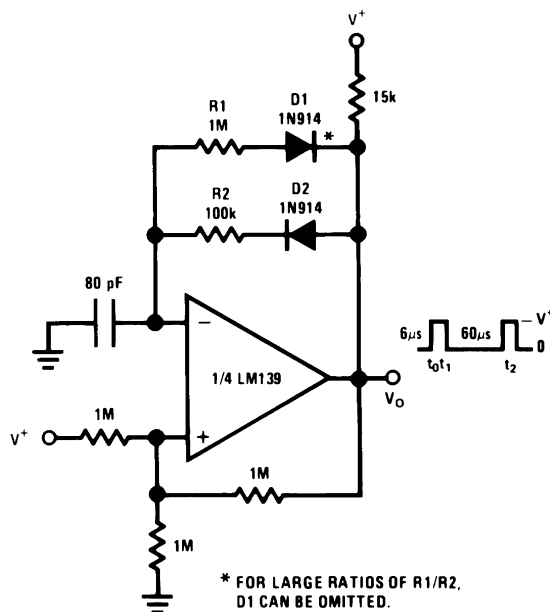
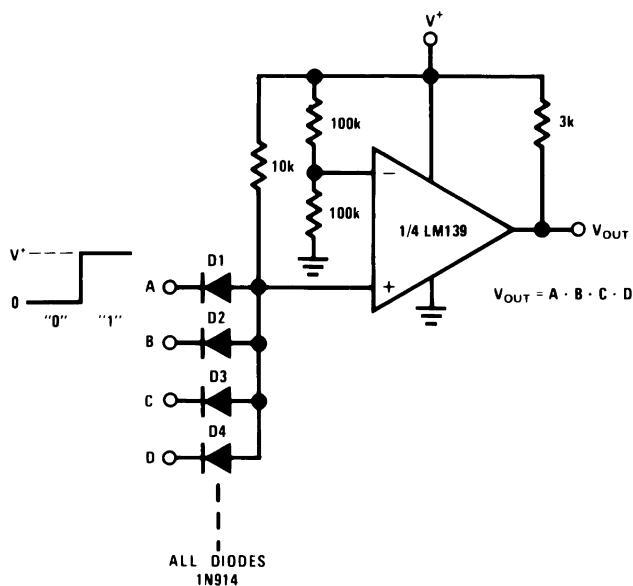
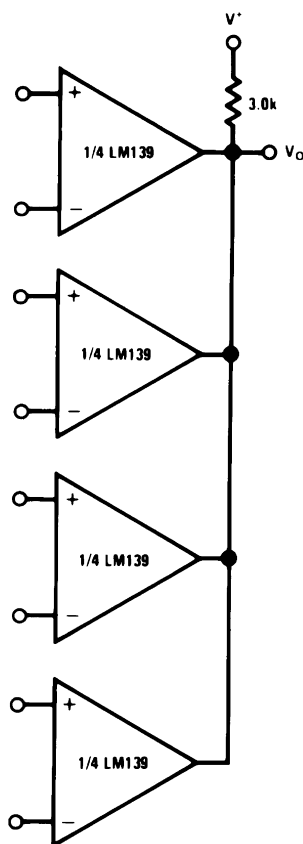


Figure 10. Large Fan-In AND Gate

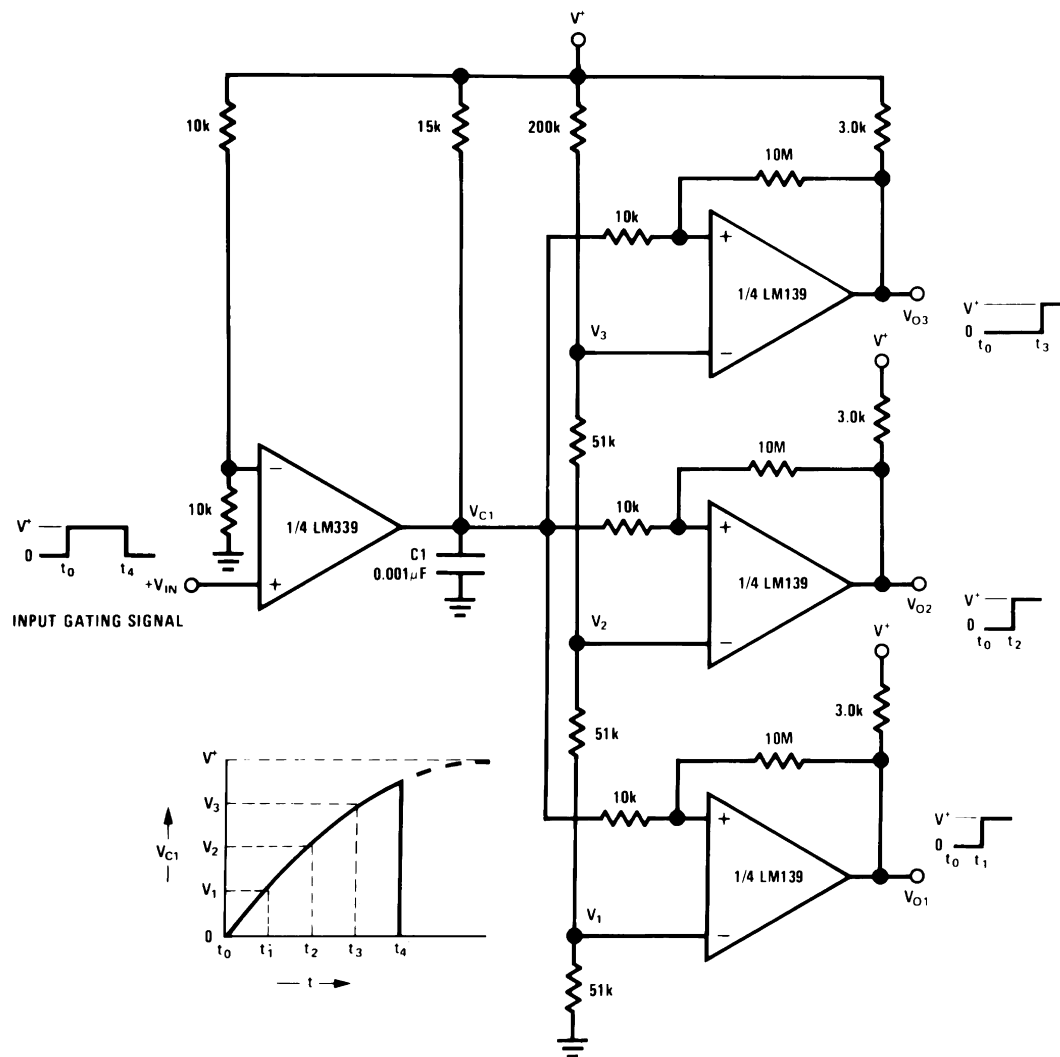


$(V^+ = 15\text{ V}_{\text{DC}})$ 

Figure 11. ORing the Outputs



### Figure 12. Time Delay Generator



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

Figure 14. Inverting Comparator with Hysteresis

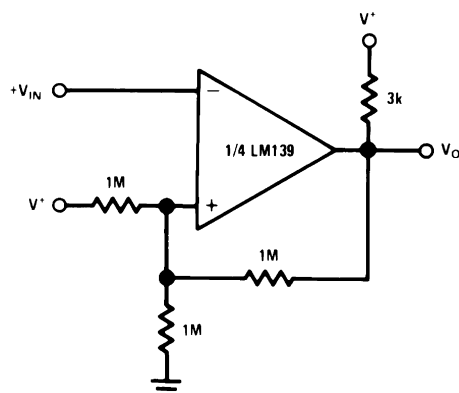


Figure 15. Squarewave Oscillator

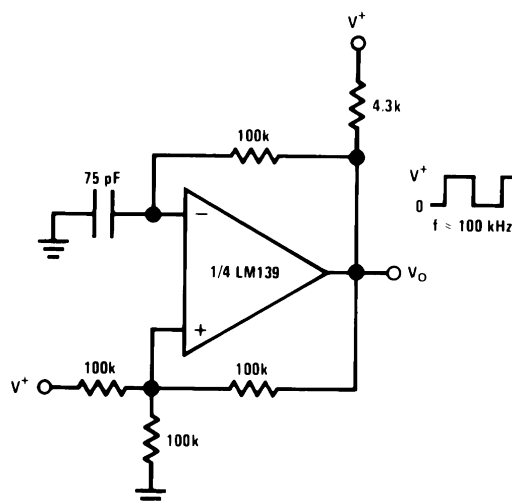
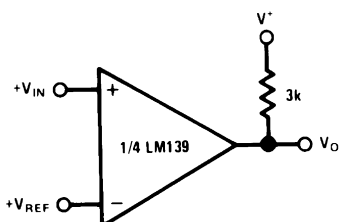


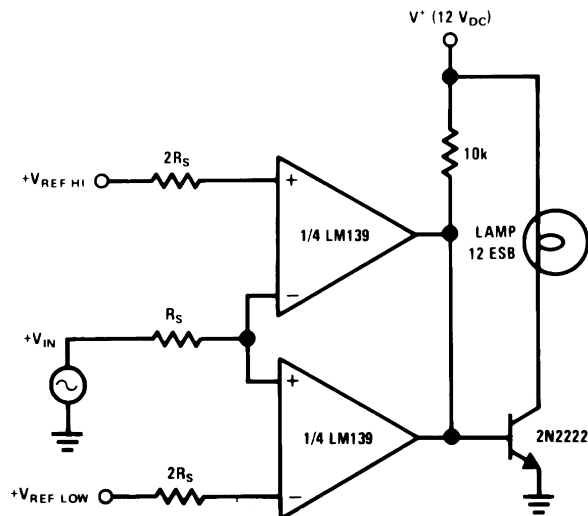
Figure 16. Basic Comparator



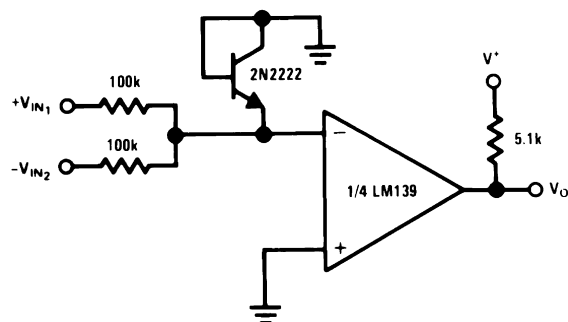


( $V^+ = 15\text{ V}_{\text{DC}}$ )

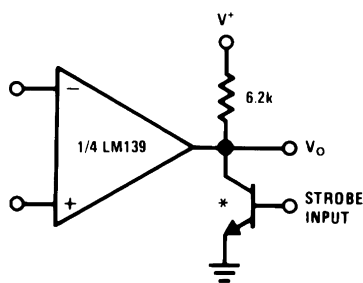
**Figure 17. Limit Comparator**



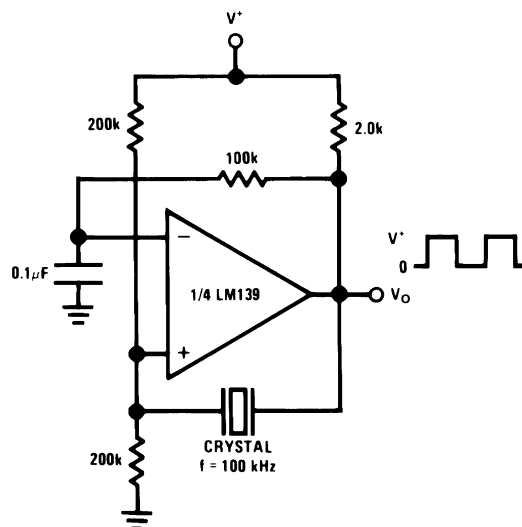
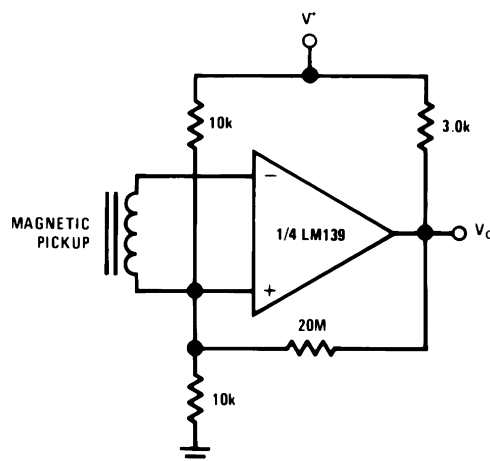
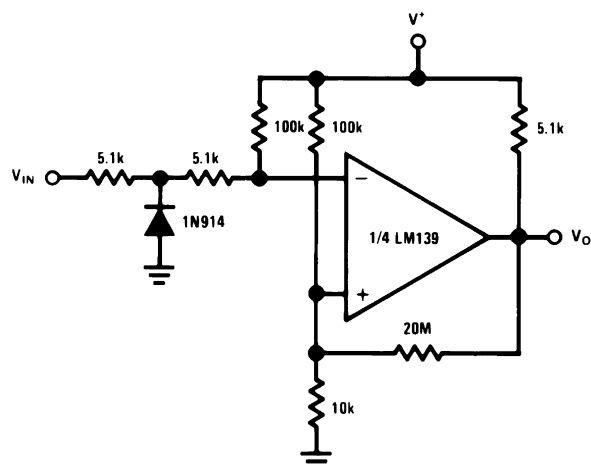
**Figure 18. Comparing Input Voltages of Opposite Polarity**



**Figure 19. Output Strobing**

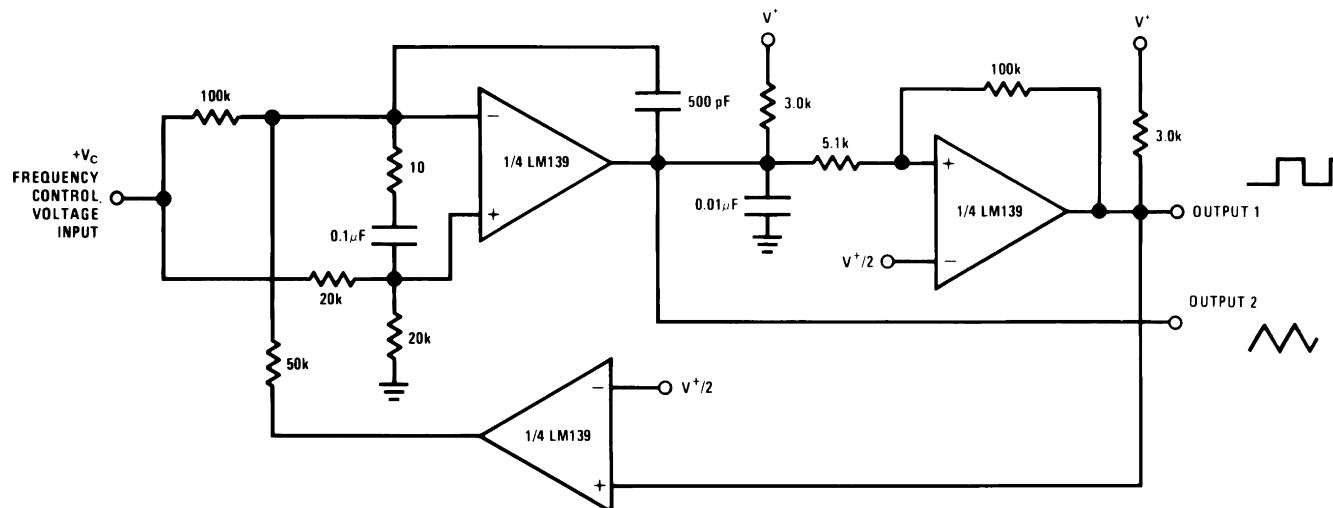


\* Or open-collector logic gate without pull-up resistor

(V<sup>+</sup> = 15 V<sub>DC</sub>)**Figure 20. Crystal Controlled Oscillator****Figure 21. Transducer Amplifier****Figure 22. Zero Crossing Detector (Single Power Supply)**

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

Figure 23. Two-Decade High-Frequency VCO

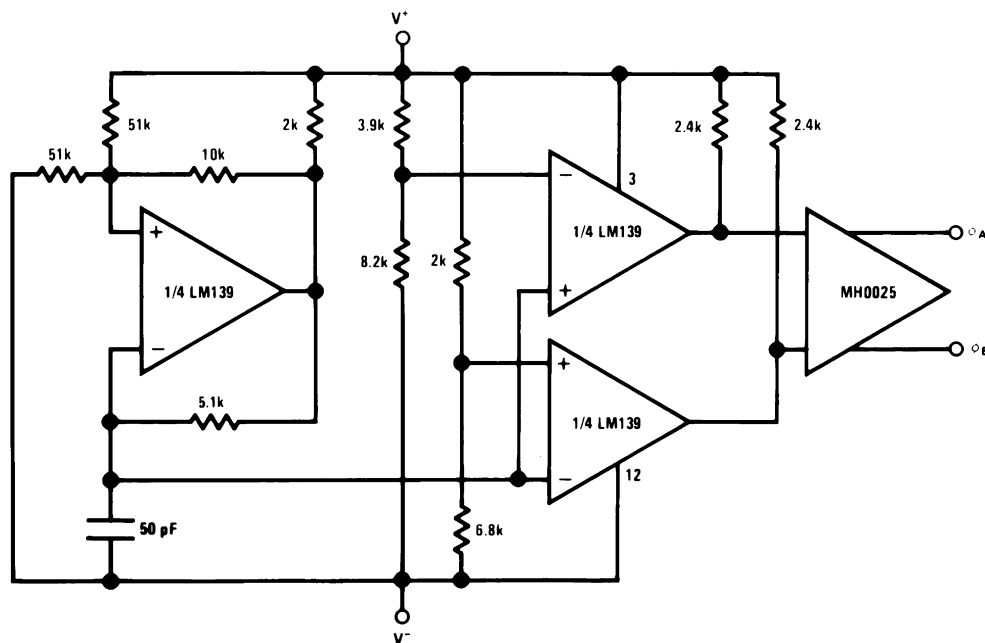


$V^+ = +30\text{ V}_{\text{DC}}$   
 $250\text{ mV}_{\text{DC}} \leq V_C \leq +50\text{ V}_{\text{DC}}$   
 $700\text{ Hz} \leq f_O \leq 100\text{ kHz}$

## Split-Supply Applications

( $V^+ = +15\text{ V}_{\text{DC}}$  and  $V^- = -15\text{ V}_{\text{DC}}$ )

Figure 24. MOS Clock Driver



( $V^+ = +15\text{ V}_{\text{DC}}$  and  $V^- = -15\text{ V}_{\text{DC}}$ )

Figure 25. Zero Crossing Detector

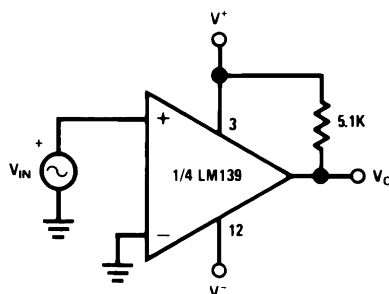
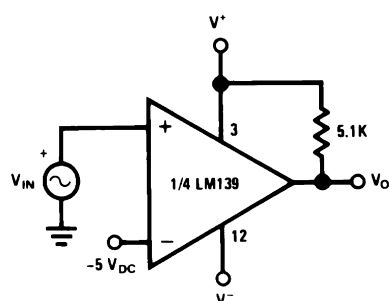


Figure 26. Comparator With a Negative Reference



**Table 1. Revision History**

Date Released	Revision	Section	Changes
02/15/05	A	New Release to corporate format	1 MDS datasheet converted into Corp. datasheet format. MJLM139-X rev 0D0. MDS datasheet will be archived.
10/26/2010	B	Order Information, Connection Diagrams, Absolute Ratings, Physical Dimensions drawings,	Update with current device information and format. Deleted J and WG pkg references. Revision A will be Archived

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
JL139BDA	ACTIVE	CLGA	NAD	14	19	TBD	A42 SNPB	Level-1-NA-UNLIM	
JM38510/11201BDA	ACTIVE	CLGA	NAD	14	19	TBD	A42 SNPB	Level-1-NA-UNLIM	
M38510/11201BDA	ACTIVE	CLGA	NAD	14	19	TBD	A42 SNPB	Level-1-NA-UNLIM	

(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.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM139JAN, LM139JAN-SP :**

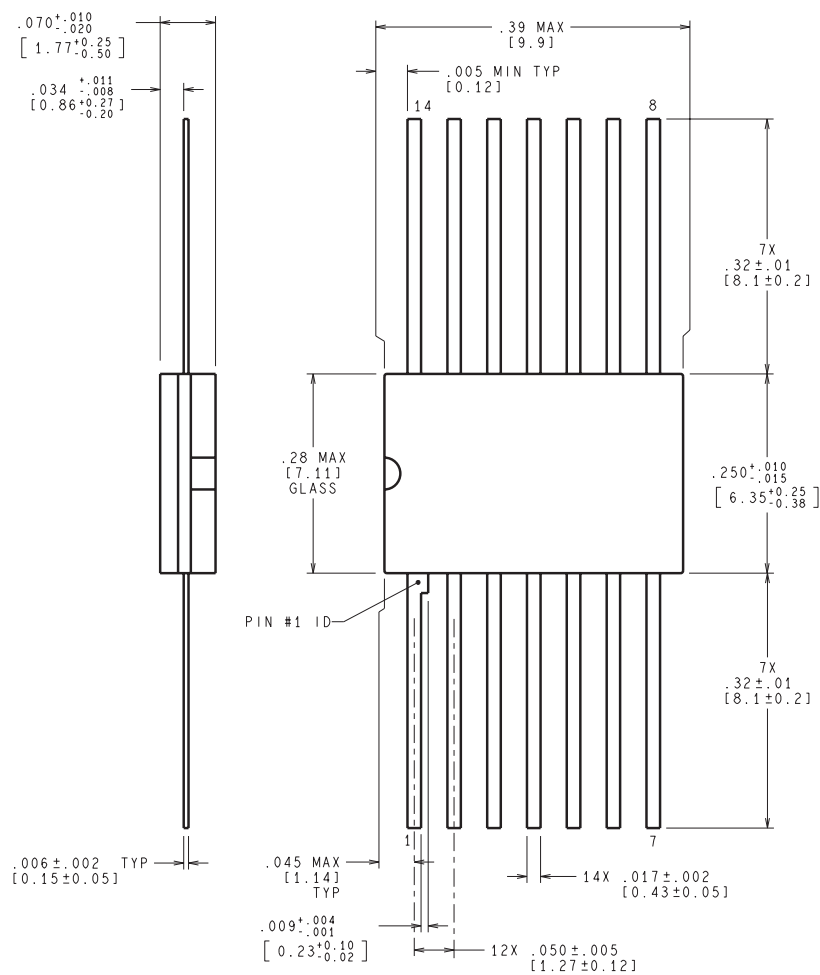
● Military: [LM139JAN](#)

● Space: [LM139JAN-SP](#)

NOTE: Qualified Version Definitions:

- Military - QML certified for Military and Defense Applications
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

NAD0014B

MIL-PRF-38535  
CONFIGURATION CONTROLMIL-STD-1835B  
CONFIGURATION CONTROLCONTROLLING DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

W14B (Rev P)



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

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

### Applications

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

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)