



LM139/LM239/LM339/LM139A/LM239A/LM339A/ LM2901/LM3302 Low Power Low Offset Voltage Quad Comparators

General Description

The LM139 series 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 series 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 LM339 is a distinct advantage over standard comparators.

Advantages

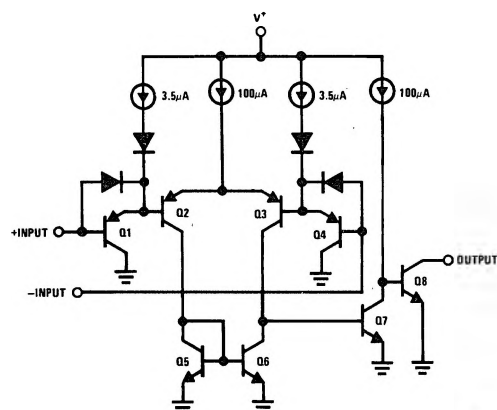
- High precision comparators
- Reduced V_{OS} drift over temperature

- Eliminates need for dual supplies
- Allows sensing near GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

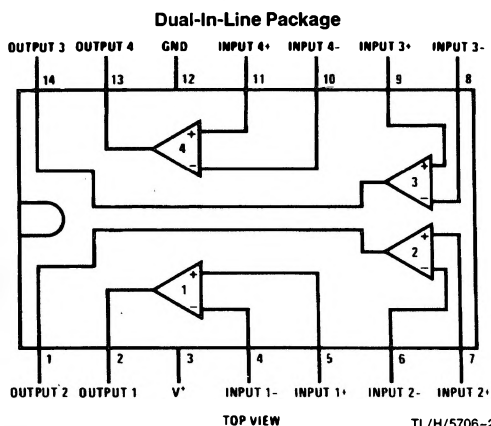
Features

- Wide single supply voltage range of dual supplies
 - LM139 series, 2 V_{DC} to 36 V_{DC} or
 - LM139A series, LM2901 $\pm 1 V_{DC}$ to $\pm 18 V_{DC}$
 - LM3302 2 V_{DC} to 28 V_{DC} or $\pm 1 V_{DC}$ to $\pm 14 V_{DC}$
- Very low supply current drain (0.8 mA) — independent of supply voltage
- Low input biasing current 25 nA
- Low input offset current ± 5 nA
- Low input offset voltage and offset voltage ± 3 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

Schematic and Connection Diagrams



TL/H/5706-1



Order Number LM139J, LM139AJ, LM239J, LM239AJ,
LM339J, LM339AJ, LM2901J or LM3302J

See NS Package Number J14A

Order Number LM339AM, LM339M or LM2901M

See NS Package Number M14A

Order Number LM339N, LM339AN,
LM2901N or LM3302N

See NS Package Number N14A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 10)

LM139/LM239/LM339
LM139A/LM239A/LM339A
LM2901

LM3302

Operating Temperature Range

28 V_{DC} or ±14 V_{DC}

36 V_{DC} or ±18 V_{DC}

Supply Voltage, V⁺

Differential Input Voltage (Note 8)

36 V_{DC}

28 V_{DC}

LM339/LM339A

0°C to +70°C

–25°C to +85°C

–40°C to +85°C

–55°C to +125°C

LM3302

Input Voltage

–0.3 V_{DC} to +36 V_{DC}

–0.3 V_{DC} to +28 V_{DC}

LM239/LM239A

–40°C to +85°C

LM3302

Input Current (V_{IN} < –0.3 V_{DC}), (Note 3)

50 mA

50 mA

LM139/LM139A

–40°C to +85°C

LM3302

Power Dissipation (Note 1)

1050 mW

1050 mW

LM339/LM339A

–260°C

LM3302

Molded DIP

1190 mW

1050 mW

LM239/LM239A

–260°C

LM3302

Cavity DIP

760 mW

1050 mW

LM239/LM239A

–260°C

LM3302

Small Outline Package

760 mW

1050 mW

LM239/LM239A

–260°C

LM3302

Output Short-Circuit to GND, (Note 2)

Continuous

Continuous

LM239/LM239A

215°C

LM3302

Storage Temperature Range

–65°C to +150°C

–65°C to +150°C

LM239/LM239A

220°C

LM3302

Lead Temperature (Soldering, 10 seconds)

260°C

260°C

LM239/LM239A

600V

LM3302

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

ESD rating (1.5 kΩ in series with 100 pF)

LM239/LM239A

600V

LM3302

Electrical Characteristics (V⁺ = 5 V_{DC}, T_A = 25°C, unless otherwise stated)

Parameter	Conditions	LM139A		LM239A, LM339A		LM139		LM239, LM339		LM2901		LM3302		Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 9)		±1.0	±2.0		±1.0	±2.0		±2.0	±5.0		±2.0	±7.0		mV _{DC}
Input Bias Current	I _{IN} (+) or I _{IN} (–) with Output in Linear Range, (Note 5), V _{CM} = 0V	25	100		25	250		25	100		25	250		nA _{DC}
Input Offset Current	I _{IN} (+) – I _{IN} (–), V _{CM} = 0V	±3.0	±25		±5.0	±50		±5.0	±50		±5	±50		nA _{DC}
Input Common-Mode Voltage Range (Note 6)	V ⁺ = 30 V _{DC} (LM3302, V ⁺ = 28 V _{DC})	0	V ⁺ – 1.5	0	V ⁺ – 1.5	0	V ⁺ – 1.5	0	V ⁺ – 1.5	0	V ⁺ – 1.5	0	V ⁺ – 1.5	V _{DC}
Supply Current	R _L = ∞ on all Comparators, R _L = ∞, V ⁺ = 36V, (LM3302, V ⁺ = 28 V _{DC})	0.8	2.0		0.8	2.0		0.8	2.0		0.8	2.0		mA _{DC}
Voltage Gain	R _L ≥ 15 kΩ, V ⁺ = 15 V _{DC} , V _O = 1 V _{DC} to 11 V _{DC}	50	200		50	200		50	200		25	100		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,	300			300			300			300			ns
Response Time (Note 7)	V _{RL} = 5 V _{DC} , R _L = 5.1 kΩ,	1.3			1.3			1.3			1.3			μs
Output Sink Current	V _{IN} (–) = 1 V _{DC} , V _{IN} (+) = 0, V _O ≤ 1.5 V _{DC}	6.0	16		6.0	16		6.0	16		6.0	16		mA _{DC}

LM139/LM239/LM339/LM139A/LM239A/LM339A/LM2901/LM3302

Electrical Characteristics (V⁺ = 5 V_{DC}, T_A = 25°C, unless otherwise stated) (Continued)

Parameter	Conditions	LM139A		LM239A, LM339A		LM139		LM239, LM339		LM2901		LM3302		Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Saturation Voltage	V _{IN(-)} = 1 V _{DC} , V _{IN(+)} = 0, I _{SINK} ≤ 4 mA	250	400	400	250	400	400	250	400	400	250	500	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			0.1			nA _{DC}

Electrical Characteristics (V⁺ = 5.0 V_{DC}, Note 4)

Parameter	Conditions	LM139A		LM239A, LM339A		LM139		LM239, LM339		LM2901		LM3302		Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	(Note 9)													
Input Offset Current	I _{IN(+)} - I _{IN(-)} , V _{CM} = 0V													mV _{DC}
Input Bias Current	I _{IN(+)} or I _{IN(-)} with Output in Linear Range, V _{CM} = 0V (Note 5)													nA _{DC}
Input Common-Mode Voltage Range	V ⁺ = 30 V _{DC} (LM3302, V ⁺ = 28 V _{DC}) (Note 6)	0	V ⁺ - 2.0	0	V ⁺ - 2.0	0	V ⁺ - 2.0	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} ≤ 4 mA													mV _{DC}
Output Leakage Current	V _{IN(+)} = 1 V _{DC} , V _{IN(-)} = 0, V _O = 30 V _{DC} (LM3302, V _O = 28 V _{DC})													μA _{DC}
Differential Input Voltage	Keep all V _{IN} 's ≥ 0 V _{DC} (or V ⁻ , if used), (Note 8)													V _{DC}

Note 1: 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 and LM139 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.

Note 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 20 mA independent of the magnitude of V⁺.

Note 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).

Note 4: These specifications are limited to -55°C ≤ T_A ≤ 125°C, for the LM139/LM139A. With the LM239/LM239A, all temperature specifications are limited to -25°C ≤ T_A ≤ 85°C, the LM339/LM339A temperature specifications are limited to 0°C ≤ T_A ≤ 70°C, and the LM2901, LM3302 temperature range is -40°C ≤ T_A ≤ 85°C.

Note 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.

Note 6: The input common-mode voltage or either input signal 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 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⁺.

Note 7: 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.

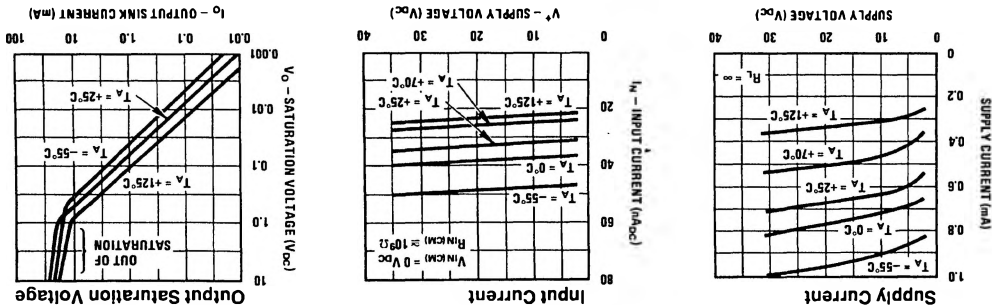
Note 8: Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V_{DC} (or 0.3 V_{DC} below the magnitude of the negative power supply, if used) (at 25°C).

Note 9: At output switch point, V_O ≈ 1.4 V_{DC}. R_S = 0Ω 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}.

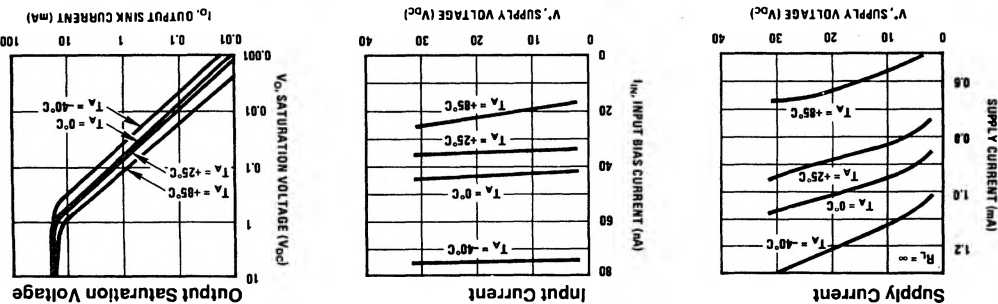
Note 10: Refer to RETS139AX for LM139AJ military specifications and to RETS139X for LM139J military specifications.

Typical Performance Characteristics

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



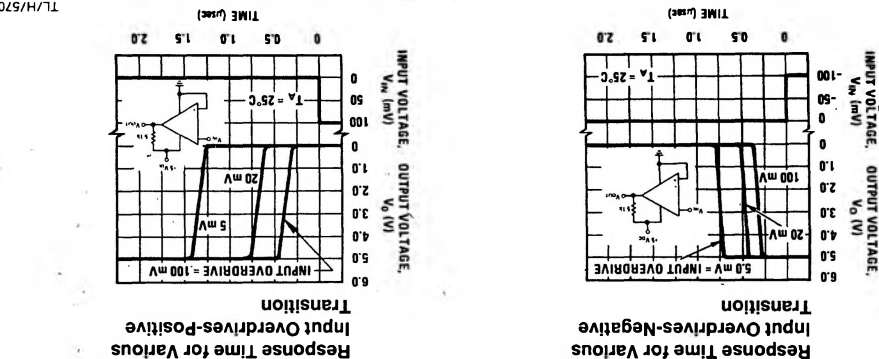
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Typical Performance Characteristics

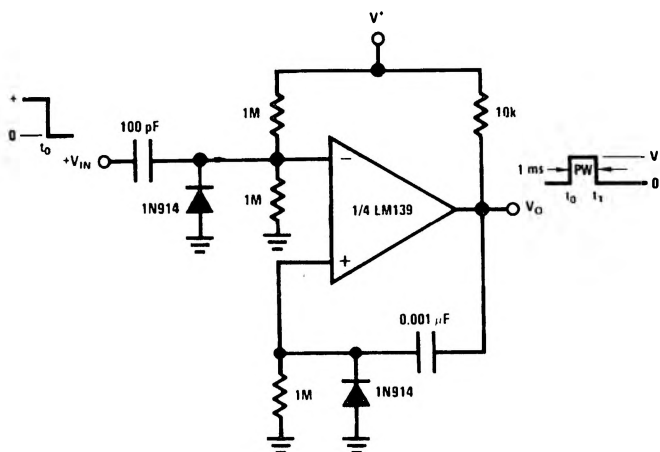
LM2901

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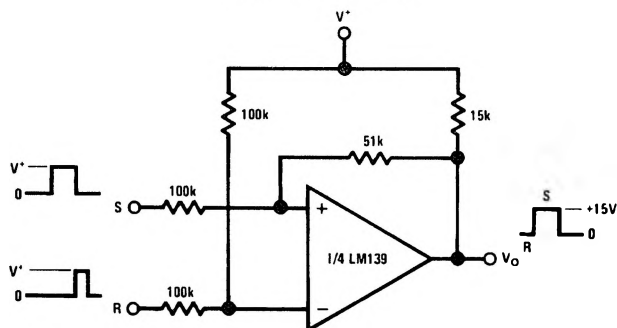
Typical Applications ($V^+ = 15\text{ V}_{\text{DC}}$) (Continued)

One-Shot Multivibrator



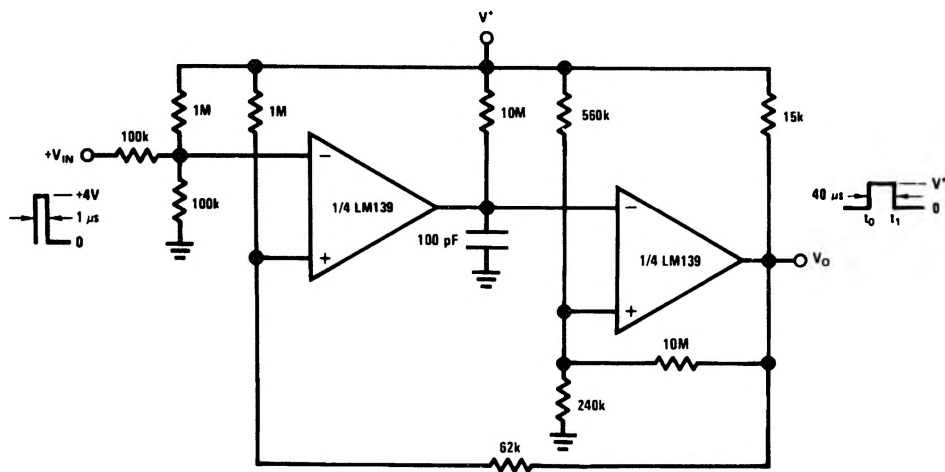
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Bi-Stable Multivibrator



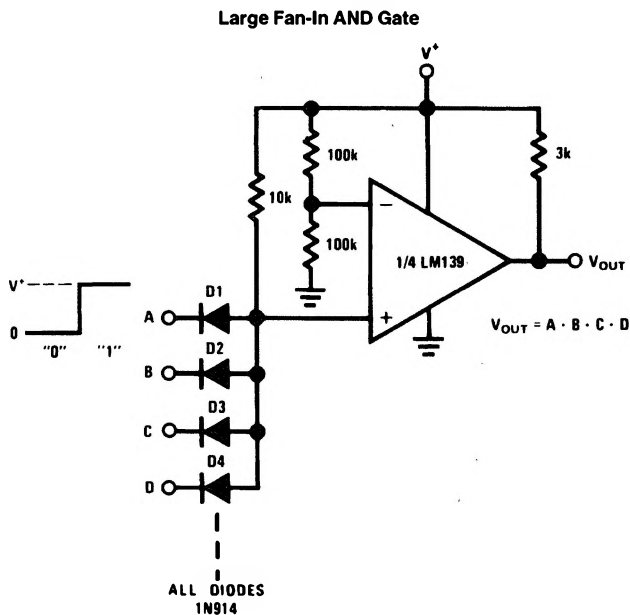
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One-Shot Multivibrator with Input Lock Out

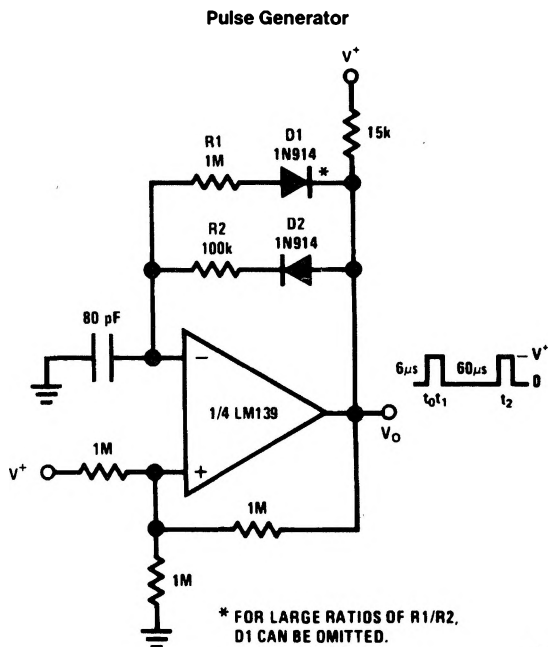


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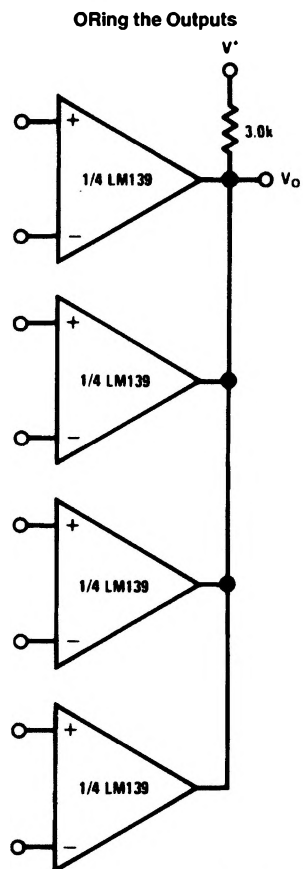
Typical Applications ($V^+ = 15\text{ V}_{\text{DC}}$) (Continued)



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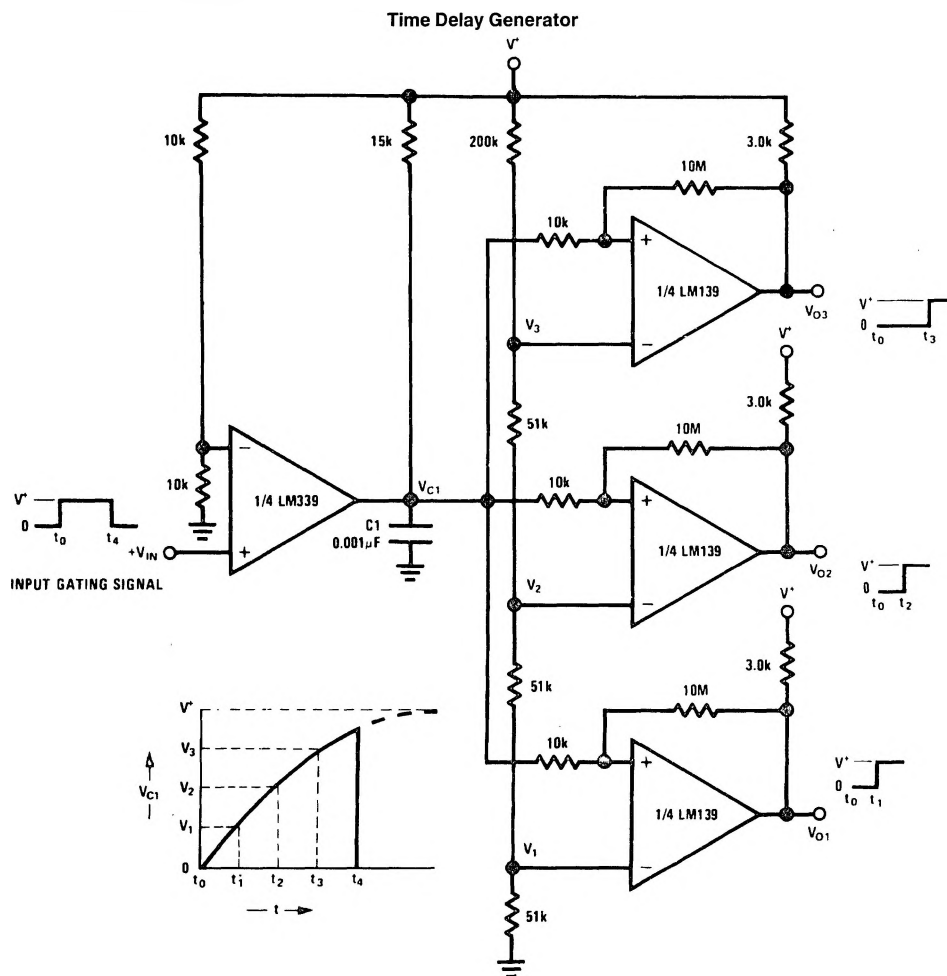


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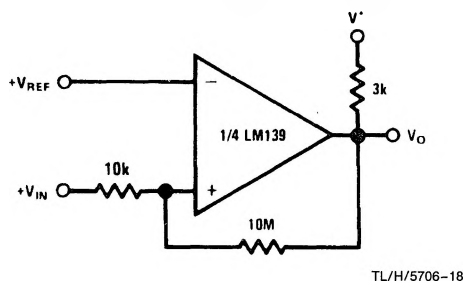
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Typical Applications ($V^+ = 15\text{ V}_{\text{DC}}$) (Continued)



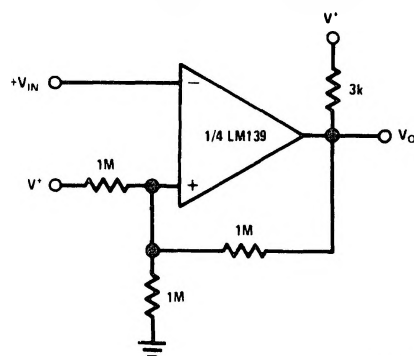
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Non-Inverting Comparator with Hysteresis



TL/H/5706-18

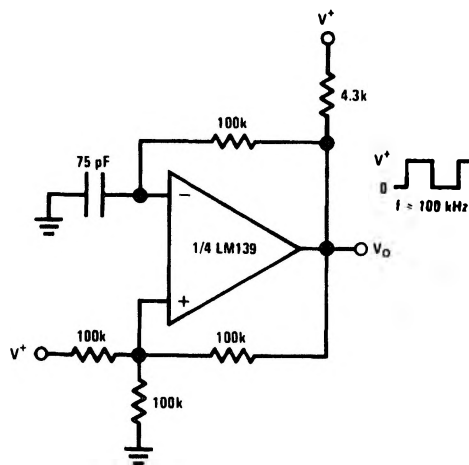
Inverting Comparator with Hysteresis



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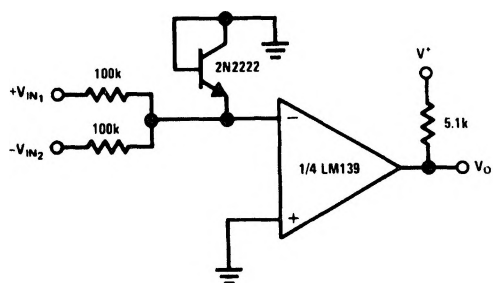
Typical Applications ($V^+ = 15\text{ V}_{\text{DC}}$) (Continued)

Squarewave Oscillator



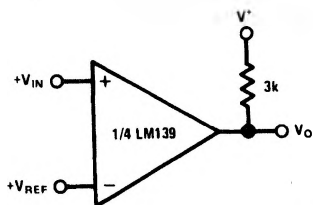
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Comparing Input Voltages of Opposite Polarity



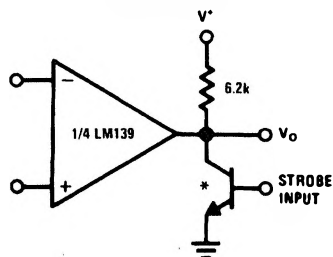
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Basic Comparator



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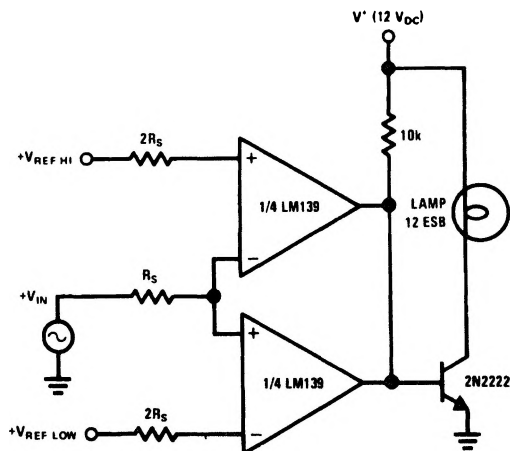
Output Strobing



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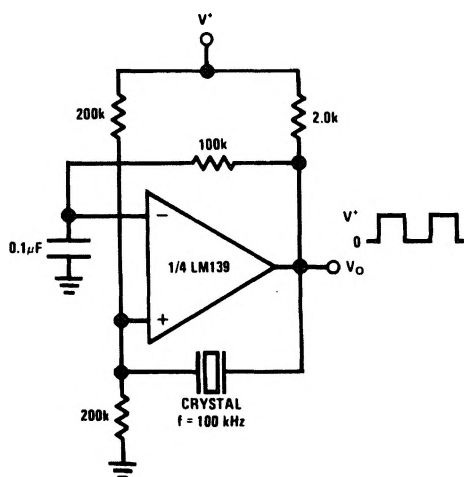
*Or open-collector logic gate without pull-up resistor

Limit Comparator



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Crystal Controlled Oscillator

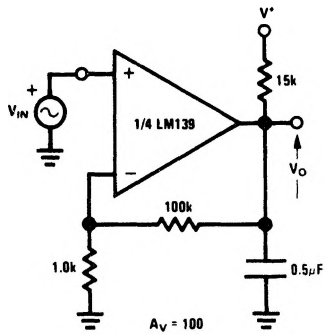


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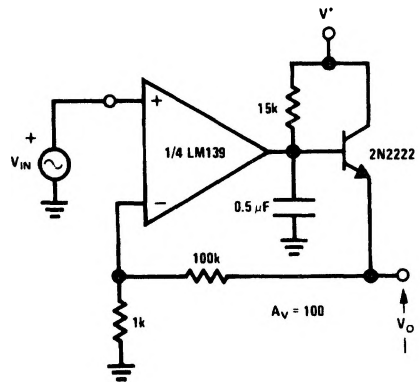
Typical Applications ($V^+ = 5\text{ V}_{\text{DC}}$) (Continued)

Low Frequency Op Amp



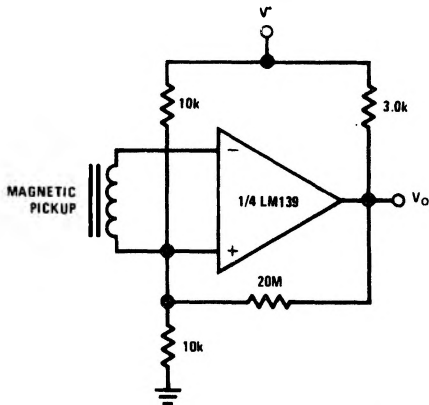
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Low Frequency Op Amp ($V_O = 0\text{V}$ for $V_{\text{IN}} = 0\text{V}$)



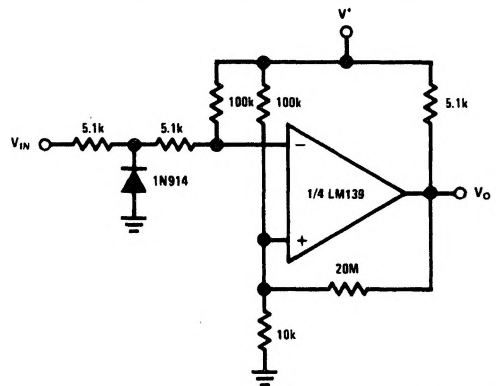
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Transducer Amplifier



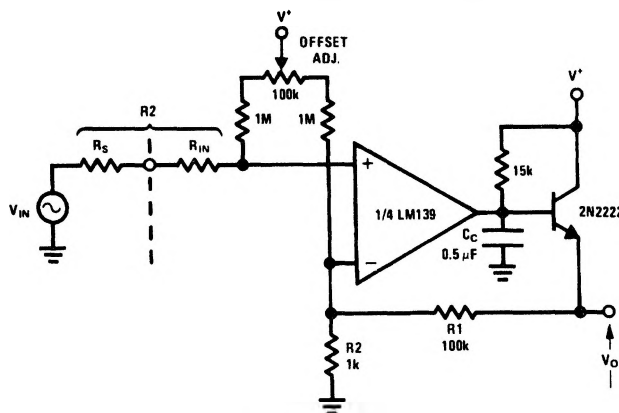
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Zero Crossing Detector (Single Power Supply)



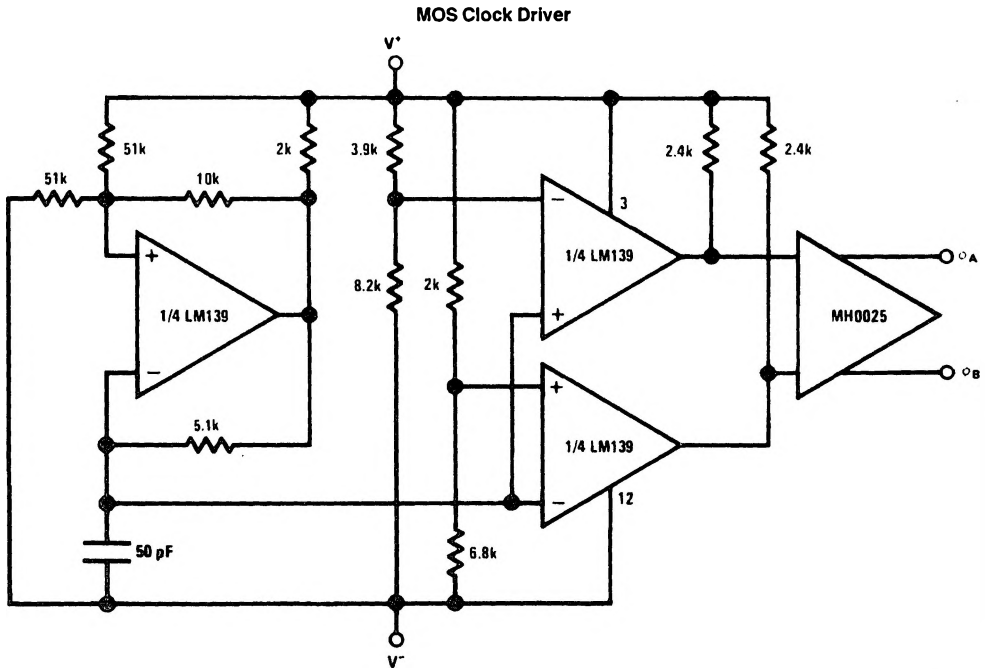
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Low Frequency Op Amp with Offset Adjust

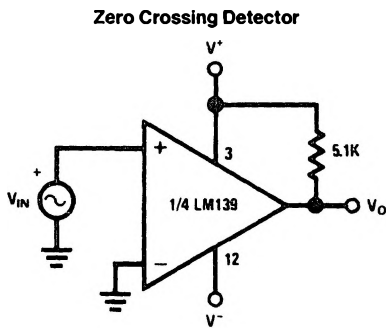


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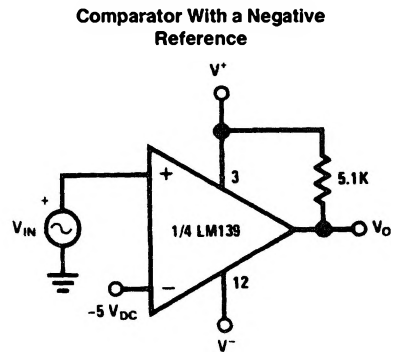
Split-Supply Applications ($V^+ = +15\text{ V}_{\text{DC}}$ and $V^- = -15\text{ V}_{\text{DC}}$)



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TL/H/5706-32



TL/H/5706-33