LM139/339
Voltage Comparators

FEATURES

- **Wide single supply voltage range or dual supplies**
- **Very low supply current drain (0.8 mA)— independent of supply voltage (2 mW/comparator at +5 V)**
- **Low input biasing current** — **25 nA**
- **Low input offset current and offset voltage** — **±5 nA, ±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**

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.

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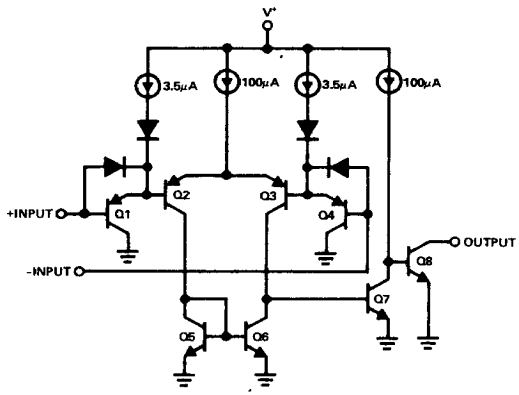
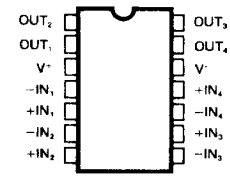
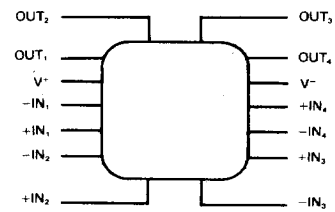
SCHEMATIC DIAGRAM



PIN CONFIGURATION



(outline dwgs JD, PD)



(outline dwg FD-1)

ORDERING INFORMATION

Part Number	Temperature Range	Dice	14 pin CCR DIP	14 pin Plastic	14 pin Flatpak
LM139 LM339	−55°C to +125°C 0°C to +70°C	LM139/D LM339/D	LM139J* LM339J	LM339N	LM139F LM339F

* Add /883B to order number if 883B processing is desired.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V^+	
Differential Input Voltage	36 V or ±18 V
Input Voltage	36 V
Power Dissipation (Note 1)	−0.3 V to +36 V
Molded DIP	570 mW
Cavity DIP	900 mW
Flat Pack	800 mW
Output Short-Circuit to GND, (Note 2)	Continuous
Input Current (V_{IN} < −0.3 V), (Note 3)	50 mA
Operating Temperature Range	
LM339	0°C to +70°C
LM139	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

NOTE:

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent device failure. These are stress ratings only and functional operation of the devices at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may cause device failures.

ELECTRICAL CHARACTERISTICS (V^+ = 5 V, Note 4)

PARAMETER	CONDITIONS	LM139			UNITS
		MIN.	TYP.	MAX.	
Input Offset Voltage	T_A = 25°C, (Note 9)		±2.0	±5.0	mV
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, T_A = 25°C, (Note 5)		25	100	nA
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$, T_A = 25°C		±3.0	±25	nA
Input Common-Mode Voltage Range	T_A = 25°C, (Note 6)	0		$V^+ - 1.5$	V
Supply Current	$R_L = \infty$ on all Comparators, T_A = 25°C				mA
	$R_L = \infty$, V^+ = 30V, T_A = 25°C		0.8	2.0	mA
Voltage Gain	$R_L \geq 15\ k\Omega$, V^+ = 15V (To Support Large V_O Swing), T_A = 25°C		200		V/mV
Large Signal Response Time	V_{IN} = TTL Logic Swing, V_{REF} = 1.4V, V_{RL} = 5V, R_L = 5.1 kΩ, T_A = 25°C		300		ns
Response Time	V_{RL} = 5 V, R_L = 5.1 kΩ, T_A = 25°C, (Note 7)		1.3		μs
Output Sink Current	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $V_O \leq 1.5$ V, T_A = 25°C	6.0	16		mA
Saturation Voltage	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA, T_A = 25°C		250	500	mV
Output Leakage Current	$V_{IN(+)} \geq 1V$, $V_{IN(-)} = 0$, V_O = 5 V, T_A = 25°C		0.1		nA
Input Offset Voltage	(Note 9)			9.0	mV
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$			±100	nA
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range			300	nA
Input Common-Mode Voltage Range		0		$V^+ - 2.0$	V
Saturation Voltage	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA			700	mV
Output Leakage Current	$V_{IN(+)} \geq 1V$, $V_{IN(-)} = 0$, V_O = 30 V			1.0	μA
Differential Input Voltage	Keep all V_{IN}'s ≥ 0 V (or V^-, if used), (Note 8)			36	V

ELECTRICAL CHARACTERISTICS (CON'T) (V^+ = 5 V

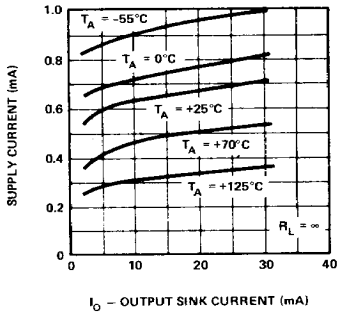
PARAMETER	CONDITIONS	LM339			UNITS
		MIN.	TYP.	MAX.	
Input Offset Voltage	T_A = 25°C, (Note 9)		±2.0	±5.0	mV
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, T_A = 25°C, (Note 5)		25	250	nA
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$, T_A = 25°C		±5.0	±50	nA
Input Common-Mode Voltage Range	T_A = 25°C, (Note 6)	0		$V^+ - 1.5$	V
Supply Current	$R_L = \infty$ on all Comparators, T_A = 25°C $R_L = \infty$, V^+ = 30V, T_A = 25°C		0.8	2.0	mA mA
Voltage Gain	$R_L \geq 15\ k\Omega$, V^+ = 15V (To Support Large V_O Swing), T_A = 25°C		200		V/mV
Large Signal Response Time	V_{IN} = TTL Logic Swing, V_{REF} = 1.4V, V_{RL} = 5V, R_L = 5.1 k Ω, T_A = 25°C		300		ns
Response Time	V_{RL} = 5 V, R_L = 5.1 k Ω, T_A = 25°C, (Note 7)		1.3		μs
Output Sink Current	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $V_O \leq 1.5$ V, T_A = 25°C	6.0	16		mA
Saturation Voltage	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA, T_A = 25°C		250	500	mV
Output Leakage Current	$V_{IN(+)} \geq 1V$, $V_{IN(-)} = 0$, V_O = 5 V, T_A = 25°C		0.1		nA
Input Offset Voltage	(Note 9)			9.0	mV
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$			±150	nA
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range			400	nA
Input Common-Mode Voltage Range		0		$V^+ - 2.0$	V
Saturation Voltage	$V_{IN(-)} \geq 1V$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA			700	mV
Output Leakage Current	$V_{IN(+)} \geq 1V$, $V_{IN(-)} = 0$, V_O = 30 V			1.0	μA
Differential Input Voltage	Keep all V_{IN}'s ≥ 0 V (or V^-, if used), (Note 8)			36	V

Note:

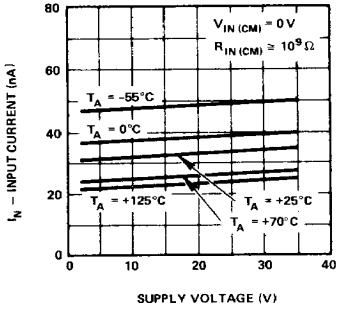
1. For operating at high temperatures, the LM339 must be derated based on a 125°C maximum junction temperature and a thermal resistance of 175°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM139 must be derated based on a 150°C maximum junction temperature. The low bias dissipation and the "ON-OFF" characteristic of the outputs keeps the chip dissipation very small ($P_D \leq 100$ mW), provided the output transistors are allowed to saturate.
2. Short circuits from the output to V^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA independent of the magnitude of V^+.
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 reestablish when the input voltage, which was negative, again returns to a value greater than −0.3V.
4. These specifications apply for V^+ = 5V and $-55°C \leq T_A \leq +125°C$, for the LM139. The LM339 temperature specifications are limited to $0°C \leq T_A \leq +70°C$.
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 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 $V^+ - 1.5$V, but either or both inputs can go to +30V without damage.
7. The response time specified is for a 100 mV input step with 5 mV overdrive signals 300 ns can be obtained, see typical performance characteristics section.
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 −0.3V (or 0.3V below the magnitude of the negative power supply, if used).
9. At output switch point, V_O = 1.4V, R_S = 0Ω with V^+ from 5V; and over the full input common-mode range (0V to $V^+ - 1.5$V).
10. For input signals that exceed V^+, only the overdriven comparator is affected. With a 5V supply V_{IN} should be limited to 25V max, and a limiting resistor should be used on all inputs that might exceed the positive supply.

TYPICAL PERFORMANCE CHARACTERISTICS

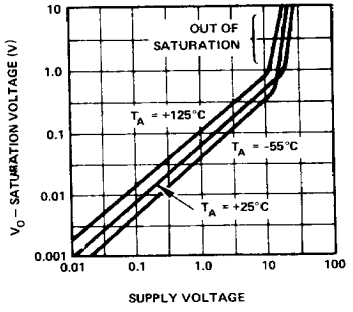
SUPPLY CURRENT



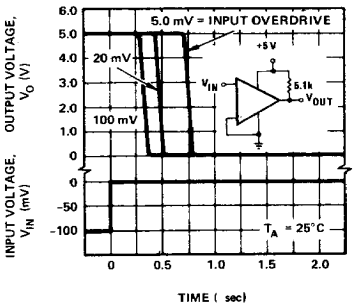
INPUT CURRENT



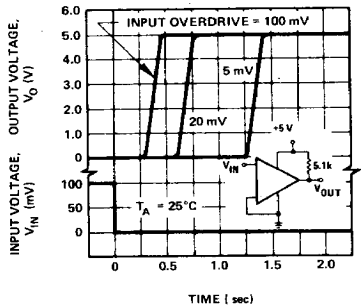
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES—NEGATIVE TRANSITION



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES—POSITIVE TRANSITION



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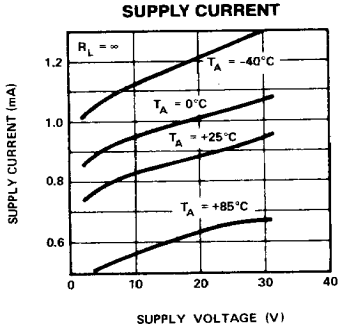
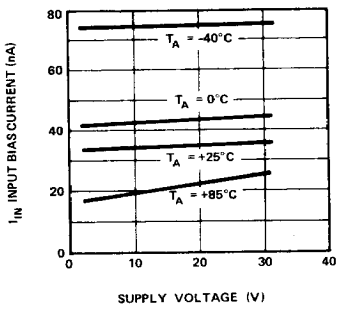
TYPICAL PERFORMANCE CHARACTERISTICS LM2901

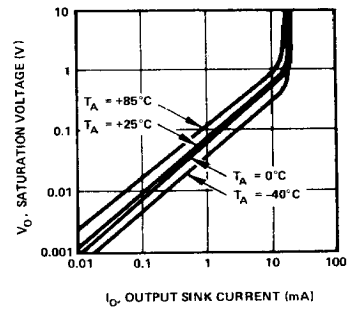
SUPPLY CURRENT



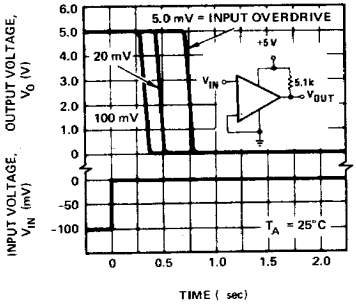
INPUT CURRENT



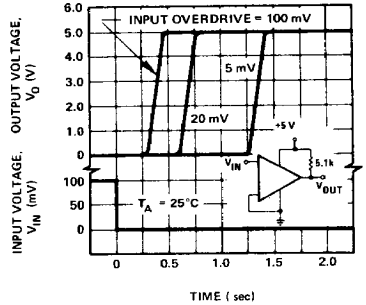
OUTPUT SATURATION VOLTAGE



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES—NEGATIVE TRANSITION



RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES—POSITIVE TRANSITION



APPLICATION HINTS

The LM139/339 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 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 $< 10\ k\Omega$ 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 grounded.

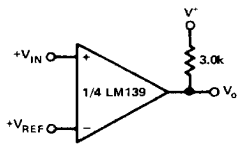
The bias network of the LM139 series establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2 V to 30 V.

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

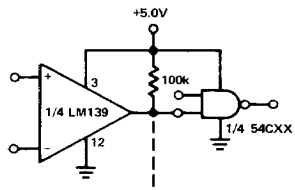
The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 V (at 25°C). An input clamp diode can be used as shown in the applications section.

The output of the LM139 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 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 LM139A 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 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 (1 mV) allows the output to clamp essentially to ground level for small load currents.

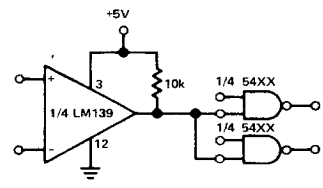
TYPICAL APPLICATIONS (V^+ =15 V)



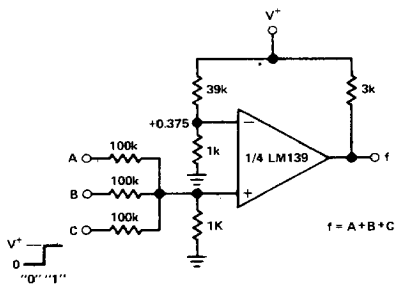
BASIC COMPARATOR



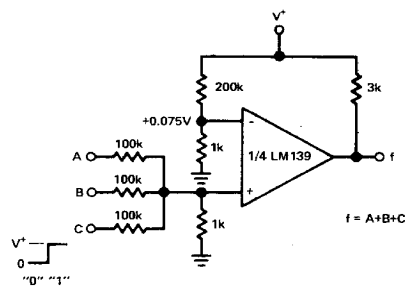
DRIVING CMOS



DRIVING TTL

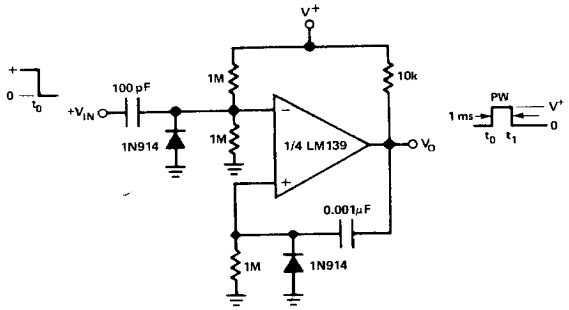


AND GATE

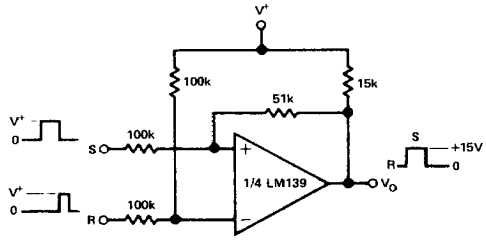


OR GATE

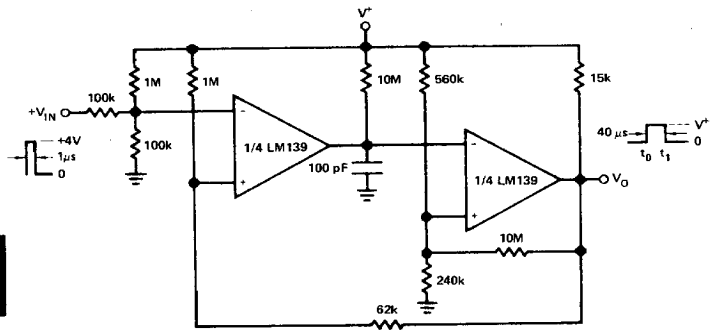
TYPICAL APPLICATIONS (CON'T) (V^+ = 15 V)



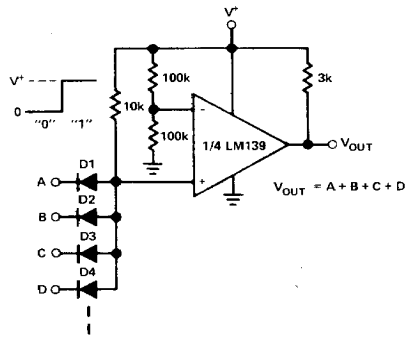
ONE-SHOT MULTIVIBRATOR



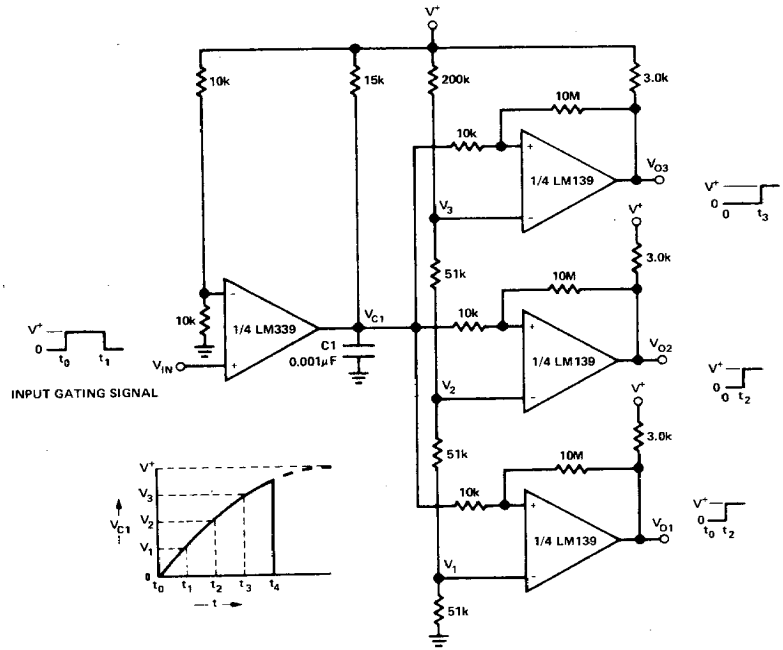
BI-STABLE MULTIVIBRATOR



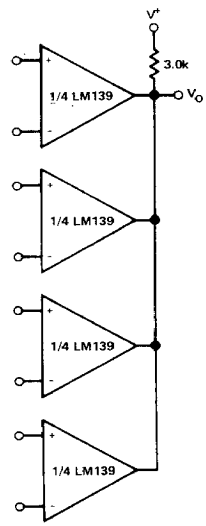
ONE-SHOT MULTIVIBRATOR WITH INPUT LOCK OUT



LARGE FAN-IN AND GATE

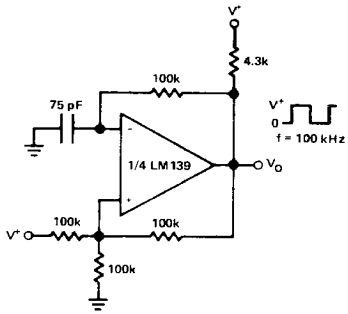


TIME DELAY GENERATOR

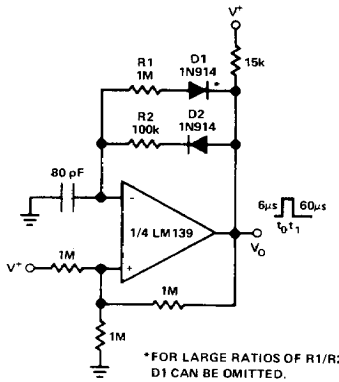


'ANDing' THE OUTPUTS

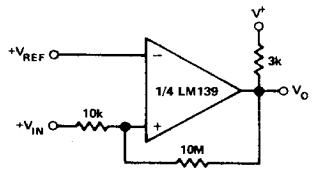
TYPICAL APPLICATIONS ($V^+ = 5.0\ V$)



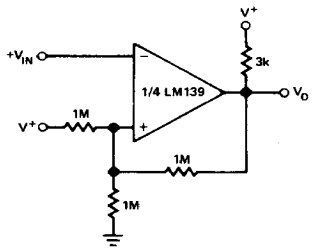
SQUAREWAVE OSCILLATOR



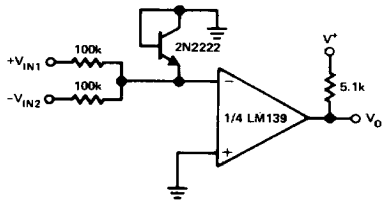
PULSE GENERATOR



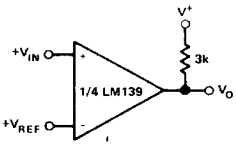
NON-INVERTING COMPARATOR WITH HYSTERESIS



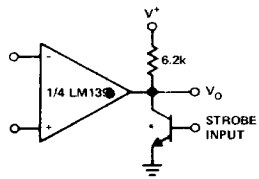
INVERTING COMPARATOR WITH HYSTERESIS



COMPARING INPUT VOLTAGES OF OPPOSITE POLARITY

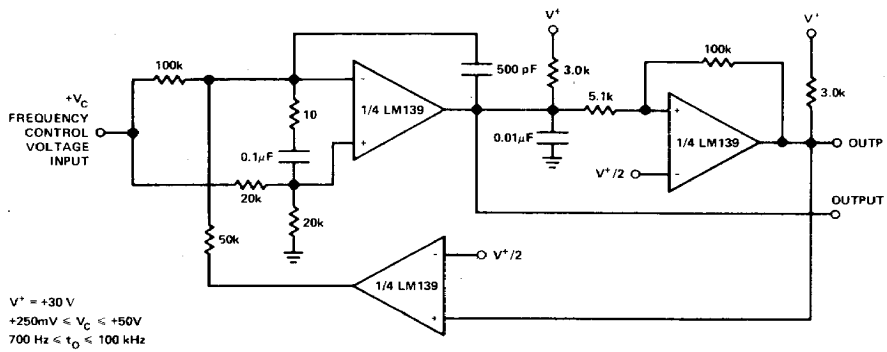


BASIC COMPARATOR



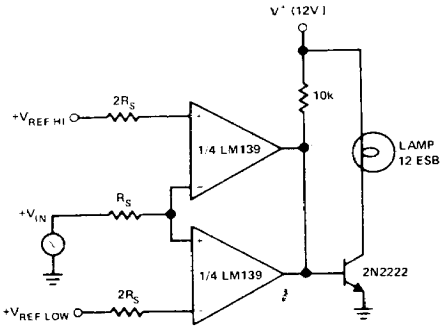
*OR LOGIC GATE WITHOUT PULL-UP RESISTOR

OUTPUT STROBING

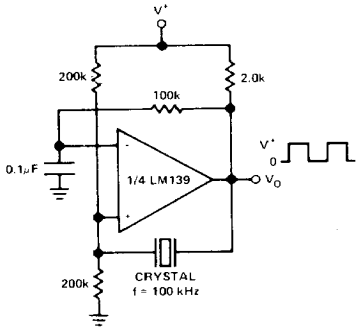


TWO-DECADE HIGH-FREQUENCY VCO

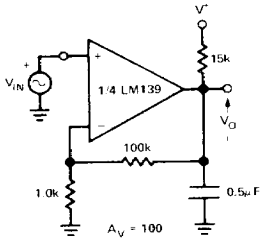
TYPICAL APPLICATIONS (CON'T) ($V^+ = 5\ V$)



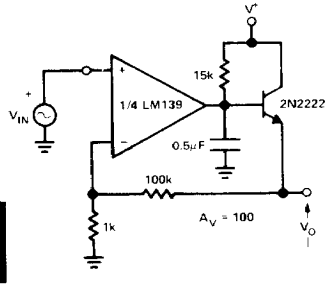
LIMIT COMPARATOR



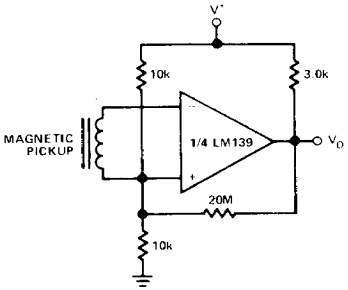
CRYSTAL CONTROLLED OSCILLATOR



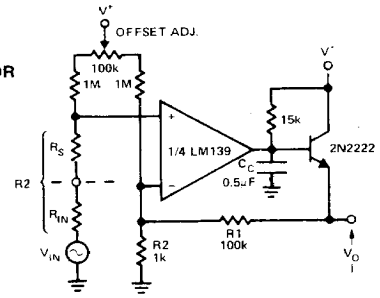
LOW FREQUENCY OP AMP



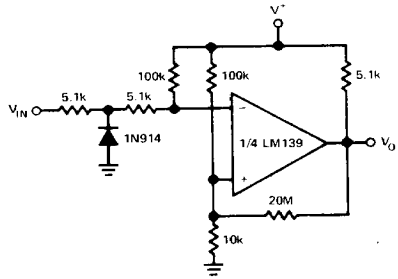
LOW FREQUENCY OP AMP
(V_O = OV FOR V_{IN} = OV)



TRANSDUCER AMPLIFIER

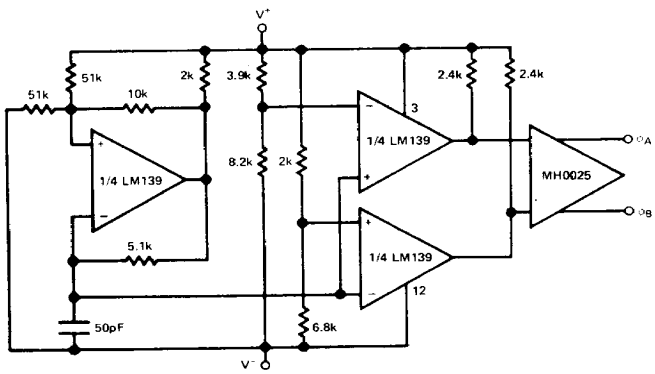


LOW FREQUENCY OP AMP
WITH OFFSET ADJUST

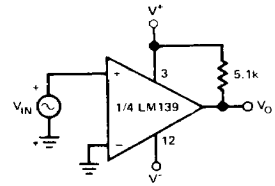


ZERO CROSSING DETECTOR
(SINGLE POWER SUPPLY)

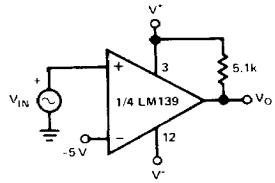
SPLIT-SUPPLY APPLICATIONS ($V^+ = +15\ V$ and $V- = -15\ V$)



MOS CLOCK DRIVER



ZERO CROSSING DETECTOR



COMPARATOR WITH A NEGATIVE REFERENCE