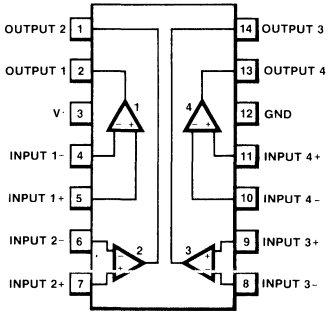
# μA139/239/339 • μA139A/239A/339A
# μA2901 • μA3302
## LOW-POWER, LOW-OFFSET VOLTAGE QUAD COMPARATORS
FAIRCHILD LINEAR INTEGRATED CIRCUITS

**GENERAL DESCRIPTION** — The μA139 series consists of four independent precision voltage comparators designed specifically to operate from a single power supply. Operation from split power supplies is also possible and the low power supply current drain is independent of the supply voltage range. Darlington connected PNP input stage allows the input common-mode voltage to include ground.

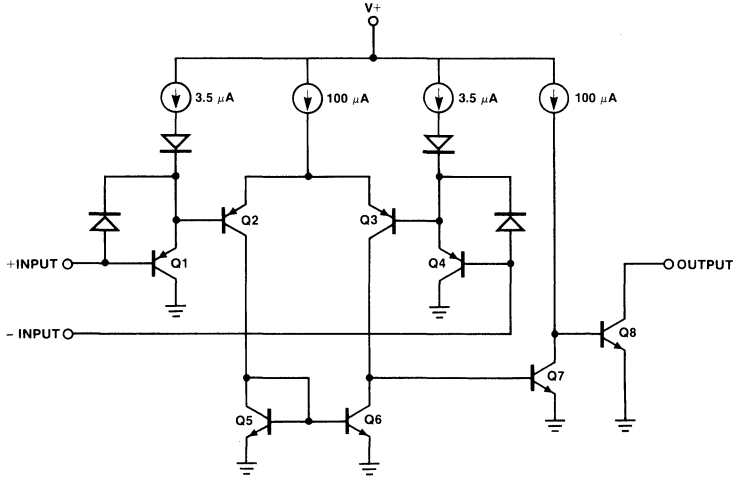
- **SINGLE SUPPLY OPERATION — +2.0 V TO +36 V**
- **DUAL SUPPLY OPERATION — ±1.0 V TO ±18 V**
- **ALLOW COMPARISON OF VOLTAGES NEAR GROUND POTENTIAL**
- **LOW CURRENT DRAIN — 800 μA TYP**
- **COMPATIBLE WITH ALL FORMS OF LOGIC**
- **LOW INPUT BIAS CURRENT — 25 nA TYP**
- **LOW INPUT OFFSET CURRENT — ±5 nA TYP**
- **LOW OFFSET VOLTAGE — ±2 mV**

**CONNECTION DIAGRAM**
**14-PIN DIP**

PACKAGE OUTLINES 6A 9A
PACKAGE CODES D P




**SCHEMATIC DIAGRAM**




**ORDER INFORMATION**

| TYPE | PART NO. |
|---|---|
| μA139A | μA139ADM |
| μA139 | μA139DM |
| μA239A | μA239ADC |
| μA239A | μA239APC |
| μA239 | μA239DC |
| μA239 | μA239PC |
| μA339A | μA339ADC |
| μA339A | μA339APC |
| μA339 | μA339DC |
| μA339 | μA339PC |
| μA2901 | μA2901DC |
| μA2901 | μA2901PC |
| μA3302 | μA3302DC |
| μA3302 | μA3302PC |

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

| CHARACTERISTICS | CONDITIONS | μA139A | | | μA239A, μA339A | | | μA139 | | | μA239, μA339 | | | μA2901 | | | μA3302 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | $T_A$ = 25°C, (Note 9) | | ±1.0 | ±2.0 | | ±1.0 | ±2.0 | | ±2.0 | ±5.0 | | ±2.0 | ±5.0 | | ±2.0 | ±7.0 | | ±3.0 | ±20 | mV |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, $T_A$ = 25°C, (Note 5) | | 25 | 100 | | 25 | 250 | | 25 | 100 | | 25 | 250 | | 25 | 250 | | 25 | 500 | nA |
| Input Offset Current | $I_{IN(+)}$ - $I_{IN(-)}$, $T_A$ = 25°C | | ±5.0 | ±25 | | ±5.0 | ±50 | | ±5.0 | ±25 | | ±5.0 | ±50 | | ±5.0 | ±50 | | ±5.0 | ±100 | nA |
| Input Common-Mode Voltage Range | $T_A$ = 25°C, (Note 6) | 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 |
| Supply Current | $R_L$ = ∞ on all Comparators, $T_A$ = 25°C<br>$R_L$ = ∞, $V^+$ = 30 V, $T_A$ = 25°C | | 0.8 | 2.0 | | 0.8 | 2.0 | | 0.8 | 2.0 | | 0.8 | 2.0 | | 0.8<br>1.0 | 1.0<br>2.5 | | 0.8 | 2.0 | mA |
| Voltage Gain | $R_L$ ≥ 15 kΩ, $V^+$ = 15 V (To Support Large $V_O$ Swing), $T_A$ = 25°C | 50 | 200 | | 50 | 200 | | | 200 | | | 200 | | 25 | 100 | | 2 | 30 | | V/mV |
| Large Signal Response Time | $V_{IN}$ = TTL Logic Swing, $V_{ref}$ = 1.4 V, $V_{RL}$ = 5.0 V, $R_L$ = 5.1 kΩ, $T_A$ = 25°C | | 300 | | | 300 | | | 300 | | | 300 | | | 300 | | | 300 | | ns |
| Response Time | $V_{RL}$ = 5.0 V, $R_L$ = 5.1 kΩ, $T_A$ = 25°C, (Note 7) | | 1.3 | | | 1.3 | | | 1.3 | | | 1.3 | | | 1.3 | | | 1.3 | | μs |
| Output Sink Current | $V_{IN(-)}$ ≥ 1.0 V, $V_{IN(+)}$ = 0, $V_O$ ≤ 1.5 V, $T_A$ = 25°C | 6.0 | 16 | | 6.0 | 16 | | 6.0 | 16 | | 6.0 | 16 | | 6.0 | 16 | | 2.0 | 16 | | mA |
| Saturation Voltage | $V_{IN(-)}$ ≥ 1.0 V, $V_{IN(+)}$ =0, $I_{sink}$ ≤ 4.0 mA, $T_A$ = 25°C | | 250 | 400 | | 250 | 400 | | 250 | 400 | | 250 | 400 | | | 400 | | 250 | 500 | mV |
| Output Leakage Current | $V_{IN(+)}$ ≥ 1.0 V, $V_{IN(-)}$ = 0, $V_O$ = 30 V, $T_A$ = 25°C | | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | nA |
| Input Offset Voltage | (Note 9) | | | 4.0 | | | 4.0 | | | 9.0 | | | 9.0 | | 9.0 | 15 | | | 40 | mV |
| Input Offset Current | $I_{IN(+)}$ - $I_{IN(-)}$ | | | ±100 | | | ±150 | | | ±100 | | | ±150 | | 50 | 200 | | | 300 | nA |
| Input Bias Current | $I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range | | | 300 | | | 400 | | | 300 | | | 400 | | 200 | 500 | | | 1000 | nA |
| Input Common-Mode Voltage Range | | 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 |
| Saturation Voltage | $V_{IN(-)}$ ≥ 1.0 V, $V_{IN(+)}$ = 0, $I_{sink}$ ≤ 4 mA | | | 700 | | | 700 | | | 700 | | | 700 | | 400 | 700 | | | 700 | mV |
| Output Leakage Current | $V_{IN(+)}$ ≥ 1.0 V, $V_{IN(-)}$ = 0, $V_O$ = 30 V | | | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | μA |
| Differential Input Voltage | Keep all $V_{IN}$'s ≥ 0 V (or V−, if used), (Note 8) | | | $V^+$ | | | $V^+$ | | | 36 | | | 36 | 0 | | $V^+$ | | | $V_{CC}$ | V |

## ABSOLUTE MAXIMUM RATINGS

| | μA139/μA239/μA339<br>μA139A/μA239A/μA339A<br>μA2901 | μA3302 |
|---|---|---|
| Supply Voltage, $V^+$ | 36 V or ±18 V | 28 V or ±14 V |
| Differential Input Voltage | 36 V | 28 V |
| Input Voltage Range | -0.3 V to +36 V | -0.3 V to +28 V |
| Power Dissipation (Note 1) | | |
| 9A, 6A | 1 W | 1 W |
| Output Short-Circuit to Gnd, (Note 2) | Continuous | Continuous |
| Input Current ($V_{IN}$ < -0.3 V), (Note 3) | 50 mA | 50 mA |
| Operating Temperature Range | | |
| μA339, μA339A | 0° C to +70° C | |
| μA239, μA239A | -25° C to +85° C | |
| μA139, μA139A | -55° C to +125° C | |
| μA2901, μA3302 | -40° C to +85° C | |
| Storage Temperature Range | -65° C to +150° C | -65° C to +150° C |
| Pin Temperature (Soldering, 10 s) | 300° C | 300° C |

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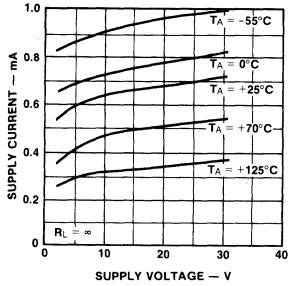
NOTES:

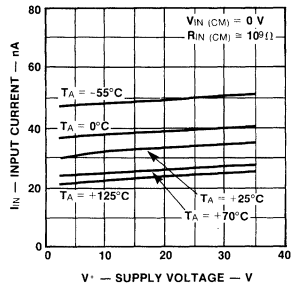
1. For operating at high temperatures, the μA339/μA339A, μA2901 μA3302 must be derated based on a 125° C maximum junction temperature and a thermal resistance of 125° C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The μA139 and μA139A must be derated 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 tiode 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 negative, again returns to a value greater than -0.3 V.
4. These specifications apply for $V^+ = 5.0$ V and -55° C ≤ $T_A$ ≤ +125° C, unless otherwise stated. With the μA239/μA239A, all temperature specifications are limited to -25° C ≤ $T_A$ ≤ +85° C, the μA339/μA339A temperature specifications are limited to 0° C ≤ $T_A$ ≤ +70° C, and the μA2901, μA3302 temperature range is -40° C ≤ $T_A$ ≤ +85° 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 0.3 V. The upper end of the common-mode voltalge range is $V^+$ -1.5 V, but either or both inputs can go to +30 V without damage.
7. The response time specified is for a 100 mV input step with 5 mV overdrive. For larger 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, comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V or 0.3 V below the magnitude of the negative power supply, if used.
9. At output switch point, $V_O \cong 1.4$ V, $R_S = 0\Omega$ with $V^+$ from 5 V; and over the full input common-mode range (0 V to $V^+$ -1.5 V).
10. For input signals that exceed $V_{CC}$, only the overdriven comparator is affected. With a 5 V supply, $V_{IN}$ should be limited to 25 V max, and a limiting resistor should be used on all inputs that might exceed the positive supply.

## TYPICAL PERFORMANCE CHARACTERISTICS
## μA139/μA239/μA339, μA139A/μA239A/μA339A, μA3302

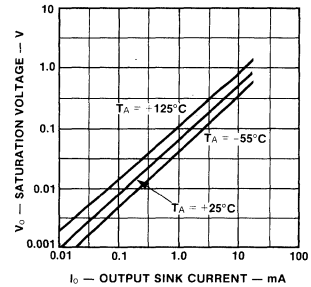
### SUPPLY CURRENT



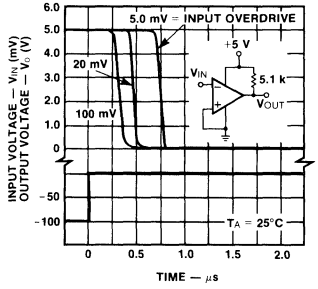

### INPUT CURRENT



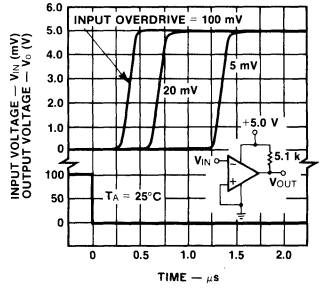

### OUTPUT SATURATION VOLTAGE




### RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES — NEGATIVE TRANSITION

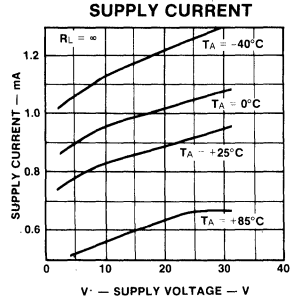



### RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES — POSITIVE TRANSITION

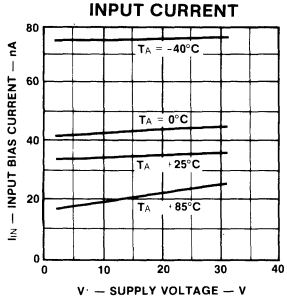



## TYPICAL PERFORMANCE CHARACTERISTICS μA2901

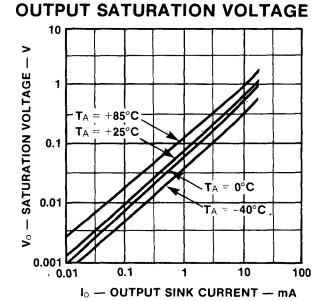
### SUPPLY CURRENT



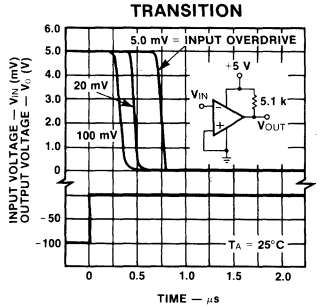

### INPUT CURRENT



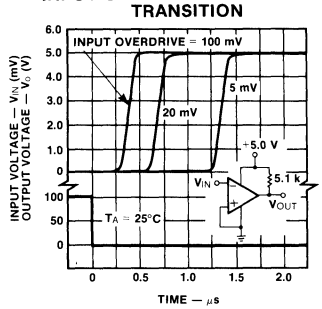

### OUTPUT SATURATION VOLTAGE




### RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES — NEGATIVE TRANSITION




### RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES — POSITIVE TRANSITION



## APPLICATION HINTS

The μA139 series are high-gain, wide-bandwidth devices which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs 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 kΩ reduces the feedback signal levels and finally, adding even a small amount (1.0 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 μA139 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.

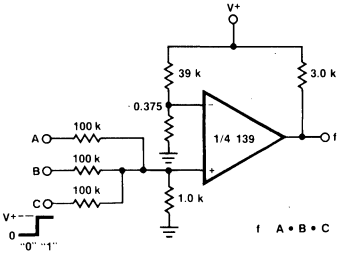
The differential input voltage may be larger than V+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than -0.3 V (at 25° C). An input clamp diode can be used as shown in the applications section.

The output of the μA139 series is the uncommitted collector of a grounded-emitter npn output transistor. Many collectors can be tied together to provide an output ORing 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 μA139 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 saturation resistance 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.

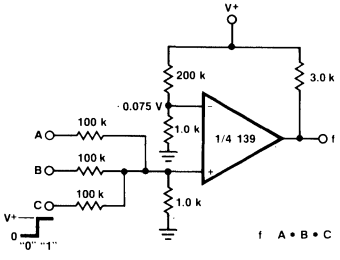


## TYPICAL APPLICATIONS (V+ = 15 V)

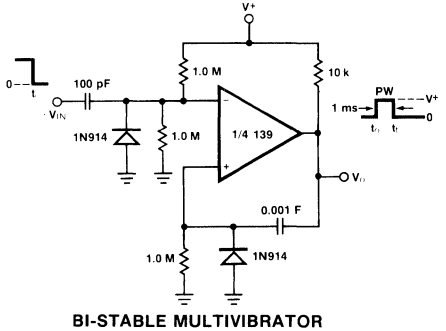
### AND GATE



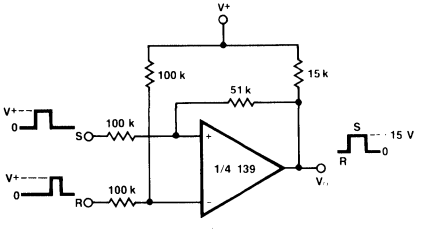

### OR GATE




### ONE-SHOT MULTIVIBRATOR

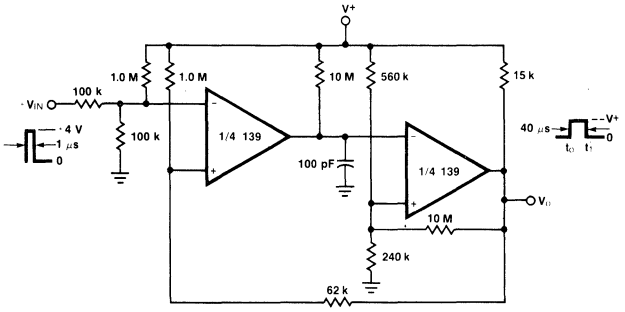



### BI-STABLE MULTIVIBRATOR

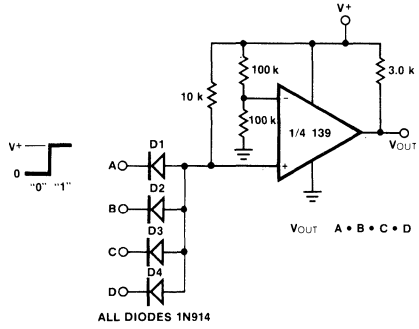


## TYPICAL APPLICATIONS (V+ = 15 V) (Cont.)

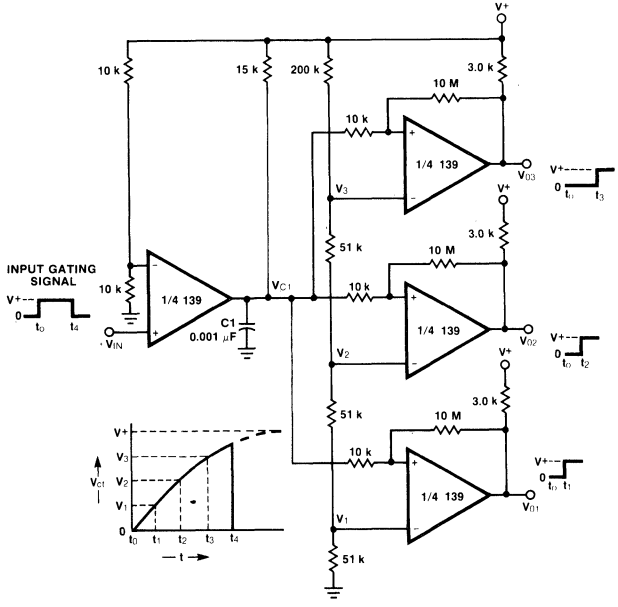
### ONE-SHOT MULTIVIBRATOR WITH INPUT LOCK OUT



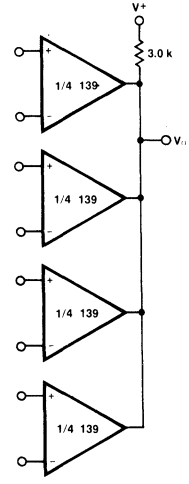

### LARGE FAN-IN AND GATE



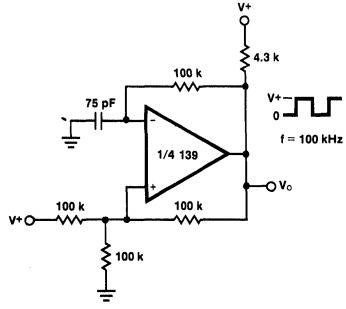

### TIME DELAY GENERATOR



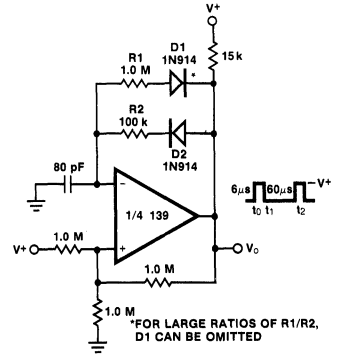

### ORING THE OUTPUTS




### SQUAREWAVE OSCILLATOR

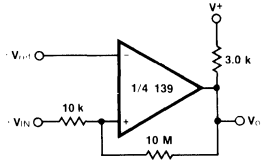



### PULSE GENERATOR

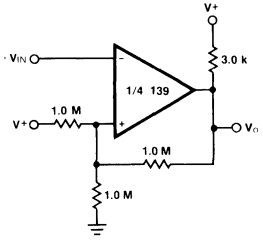


## TYPICAL APPLICATIONS (V+ = 15 V) (Cont.)

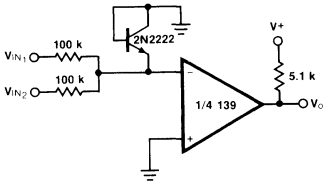
### NON-INVERTING COMPARATOR WITH HYSTERESIS



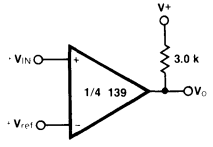

### INVERTING COMPARATOR WITH HYSTERESIS



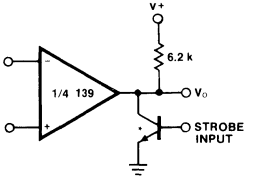

### COMPARING INPUT VOLTAGES OF OPPOSITE POLARITY




### BASIC COMPARATOR

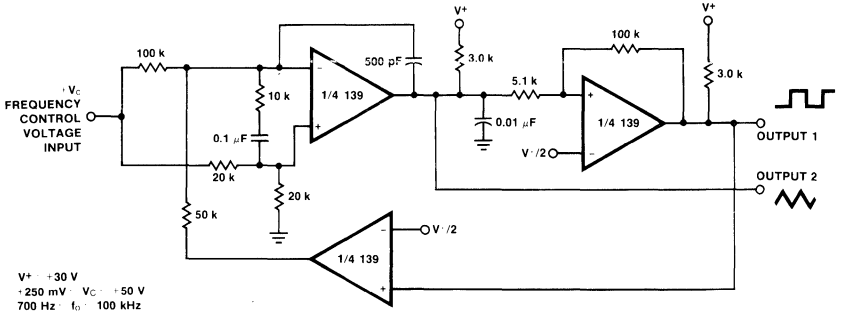



### OUTPUT STROBING

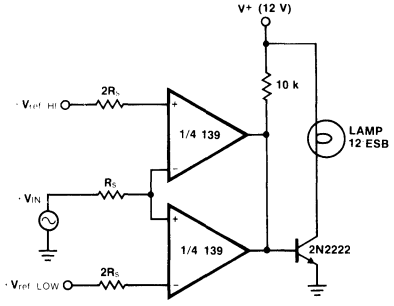



*OR LOGIC GATE WITHOUT PULL-UP RESISTOR

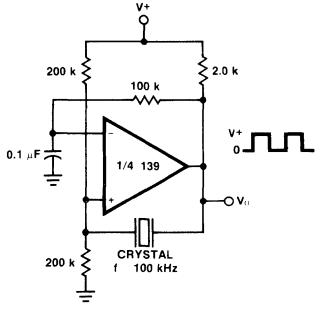
### TWO-DECADE HIGH-FREQUENCY VCO




### LIMIT COMPARATOR

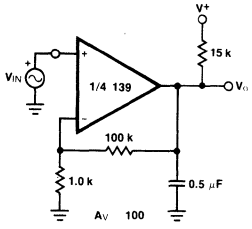



### CRYSTAL CONTROLLED OSCILLATOR

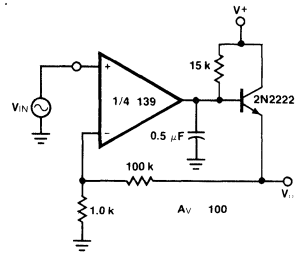


## TYPICAL APPLICATIONS (V+ = 15 V) (Cont.)

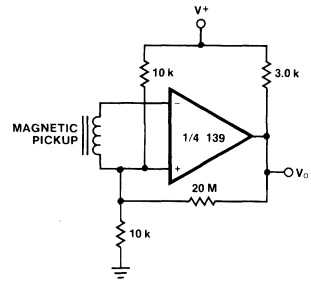
### LOW FREQUENCY OP AMP



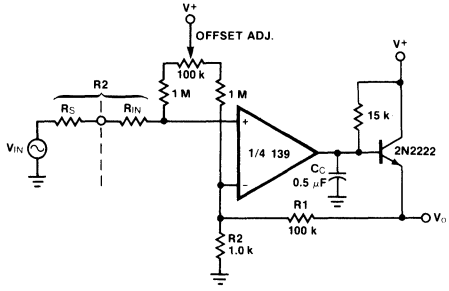

### LOW FREQUENCY OP AMP (VO = 0 V FOR VIN = 0 V)



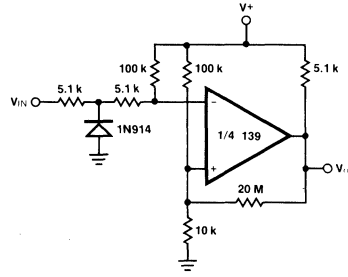

### TRANSDUCER AMPLIFIER




### LOW FREQUENCY OP AMP WITH OFFSET ADJUST

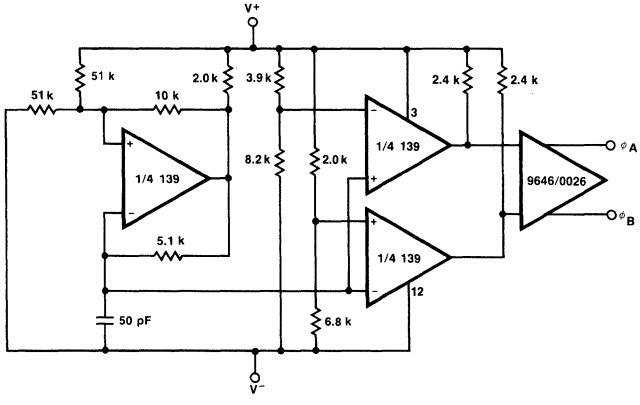



### ZERO CROSSING DETECTOR (SINGLE POWER SUPPLY)

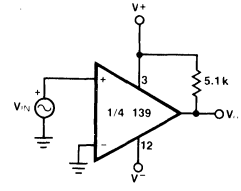



## SPLIT-SUPPLY APPLICATIONS V+ = +15V and V− = -15V

### MOS CLOCK DRIVER




### ZERO CROSSING DETECTOR




### COMPARATOR WITH A NEGATIVE REFERENCE