LM2901EP Low Power Low Offset Voltage Quad Comparators

Check for Samples: LM2901EP

FEATURES

- **Wide Supply Voltage Range**
- **LM2901: 2 to 36 V_{DC} or ±1 to ±18 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**
- **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**

ADVANTAGES

- **High Precision Comparator**
- **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**

APPLICATIONS

- **Selected Military Applications**
- **Selected Avionics Applications**

DESCRIPTION

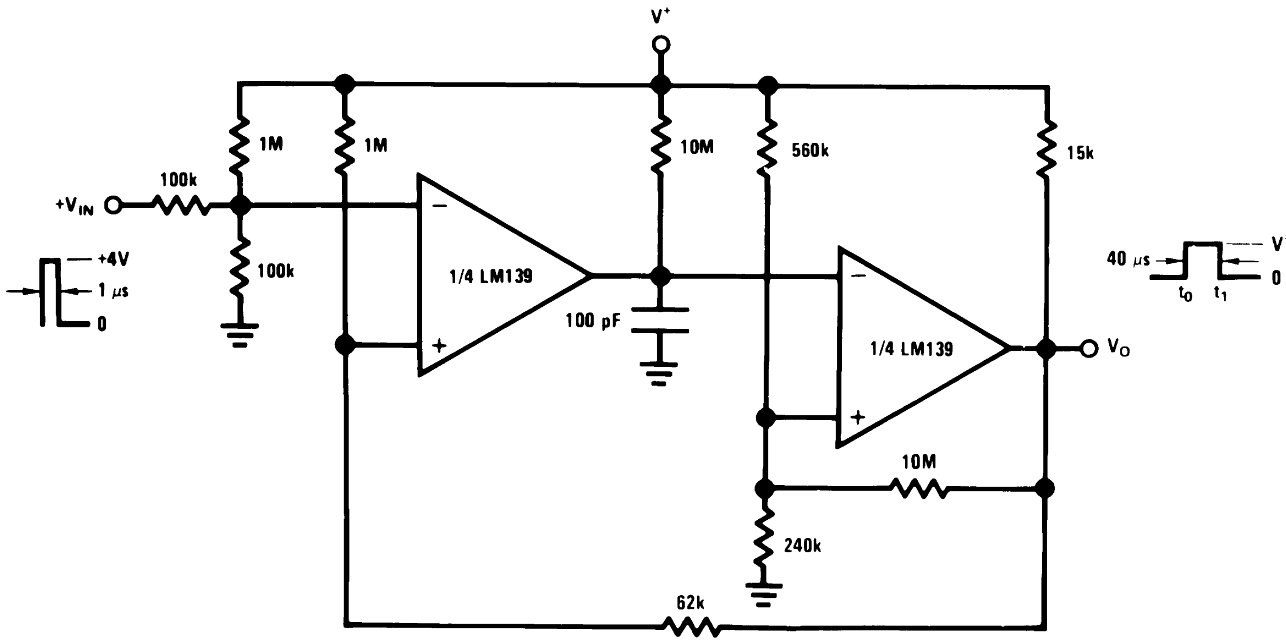
The LM2901EP consists of four independent precision voltage comparators with an offset voltage specification as low as 2 mV max for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. This comparator also has 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 LM2901EP was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, it will directly interface with MOS logic— where the low power drain of the LM2901EP is a distinct advantage over standard comparators.

ENHANCED PLASTIC

- Extended Temperature Performance of −40°C to +85°C
- Baseline Control - Single Fab & Assembly Site
- Process Change Notification (PCN)
- Qualification & Reliability Data
- Solder (PbSn) Lead Finish is standard
- Enhanced Diminishing Manufacturing Sources (DMS) Support

One-Shot Multivibrator with Input Lock Out



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(1)(2)

Supply Voltage, V^+			36 V_{DC} or ±18 V_{DC}
Differential Input Voltage(3)			36 V_{DC}
Input Voltage			−0.3 V_{DC} to +36 V_{DC}
Input Current (V_{IN}<−0.3 V_{DC}),(4)			50 mA
Power Dissipation(5)	Molded PDIP		1050 mW
	Small Outline Package (SOIC)		760 mW
Output Short-Circuit to GND,(6)			Continuous
Storage Temperature Range			−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)			260°C
Operating Temperature Range	LM2901		−40°C to +85°C
Soldering Information	Dual-In-Line Package	Soldering (10 seconds)	260°C
	Small Outline Package	Vapor Phase (60 seconds)	215°C
		Infrared (15 seconds)	220°C
ESD rating (1.5 kΩ in series with 100 pF)			600V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.
(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°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°)C.
(5) For operating at high temperatures, the LM2901EP 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 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.
(6) 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^+.

ELECTRICAL CHARACTERISTICS(1)

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

Parameter	Conditions	LM2901			Units
		Min	Typ	Max	
Input Offset Voltage	See(2)		2.0	7.0	mV_{DC}
Input Bias Current	$I_{IN(+)}$ or $I_{IN(−)}$ with Output in Linear Range,(3), V_{CM}=0V		25	250	nA_{DC}
Input Offset Current	$I_{IN(+)}−I_{IN(−)}$, V_{CM} = 0V		5	50	nA_{DC}
Input Common-Mode Voltage Range	V^+ = 30 V_{DC}(4)	0		V^+−1.5	V_{DC}
Supply Current	R_L = ∞ on all Comparators,		0.8	2.0	mA_{DC}
	R_L = ∞, V^+ = 36V,		1.0	2.5	mA_{DC}
Voltage Gain	R_L ≥ 15 kΩ, V^+ = 15 V_{DC} V_O = 1 V_{DC} to 11 V_{DC}	25	100		V/mV

(1) "Testing and other quality control techniques are used to the extent deemed necessary to ensure product performance over the specified temperature range. Product may not necessarily be tested across the full temperature range and all parameters may not necessarily be tested. In the absence of specific PARAMETRIC testing, product performance is assured by characterization and/or design."
(2) 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.
(3) 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.
(4) 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 independent of the magnitude of V^+.

ELECTRICAL CHARACTERISTICS(1) (continued)

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

Parameter	Conditions	LM2901			Units
		Min	Typ	Max	
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		ns
Response Time	V_{RL} = 5 V_{DC}, R_L = 5.1 kΩ,(5)		1.3		μs
Output Sink Current	$V_{IN(-)}$= 1 V_{DC}, $V_{IN(+)}$ = 0, V_O ≤ 1.5 V_{DC}	6.0	16		mA_{DC}
Saturation Voltage	$V_{IN(-)}$ = 1 V_{DC}, $V_{IN(+)}$ = 0, I_{SINK} ≤ 4 mA		250	400	mV_{DC}
Output Leakage Current	$V_{IN(+)}$ = 1 V_{DC},$V_{IN(-)}$ = 0, V_O = 5 V_{DC}		0.1		nA_{DC}

(5) 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.

ELECTRICAL CHARACTERISTICS(1)

(V^+ = 5.0 V_{DC})(2)

Parameter	Conditions	LM2901			Units
		Min	Typ	Max	
Input Offset Voltage	See(3)		9	15	mV_{DC}
Input Offset Current	$I_{IN(+)}-I_{IN(-)}$, V_{CM} = 0V		50	200	nA_{DC}
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$ with Output in Linear Range, V_{CM} = 0V(4)		200	500	nA_{DC}
Input Common-Mode Voltage Range	V^+ = 30 V_{DC}(5)	0		V^+−2.0	V_{DC}
Saturation Voltage	$V_{IN(-)}$ = 1 V_{DC}, $V_{IN(+)}$ = 0, I_{SINK} ≤ 4 mA		400	700	mV_{DC}
Output Leakage Current	$V_{IN(+)}$ = 1 V_{DC}, $V_{IN(-)}$ = 0, V_O = 30 V_{DC}			1.0	$μA_{DC}$
Differential Input Voltage	Keep all V_{IN}'s ≥ 0 V_{DC} (or V^-, if used),(6)			36	V_{DC}

(1) "Testing and other quality control techniques are used to the extent deemed necessary to ensure product performance over the specified temperature range. Product may not necessarily be tested across the full temperature range and all parameters may not necessarily be tested. In the absence of specific PARAMETRIC testing, product performance is assured by characterization and/or design."
(2) These specifications are limited to −40°C ≤ T_A ≤ +85°C, for the LM2901EP.
(3) 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.
(4) 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.
(5) 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 independent of the magnitude of V^+.
(6) 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).

TYPICAL PERFORMANCE CHARACTERISTICS

Supply Current

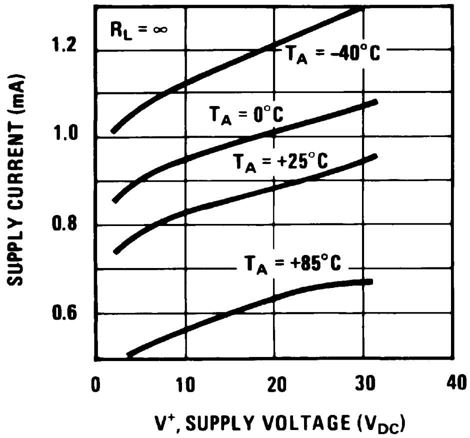


Figure 1.

Input Current

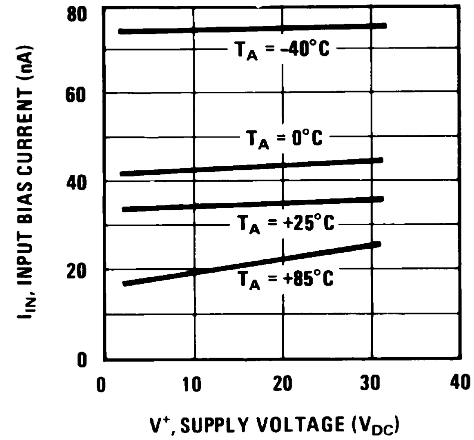


Figure 2.

Output Saturation Voltage

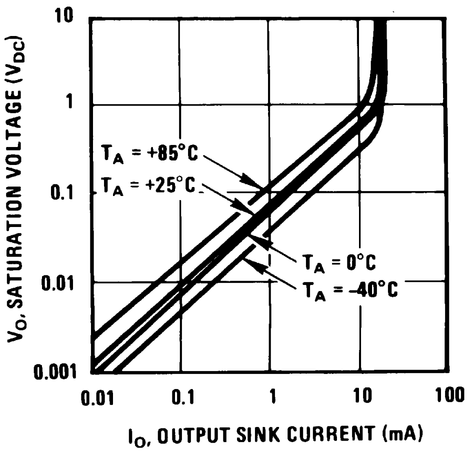


Figure 3.

Response Time for Various Input Overdrives —Negative Transition

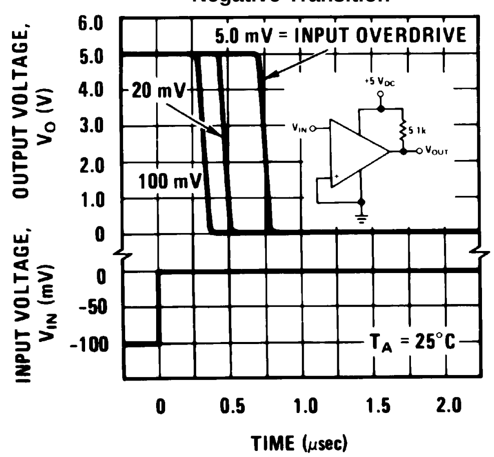


Figure 4.

Response Time for Various Input Overdrives —Positive Transition

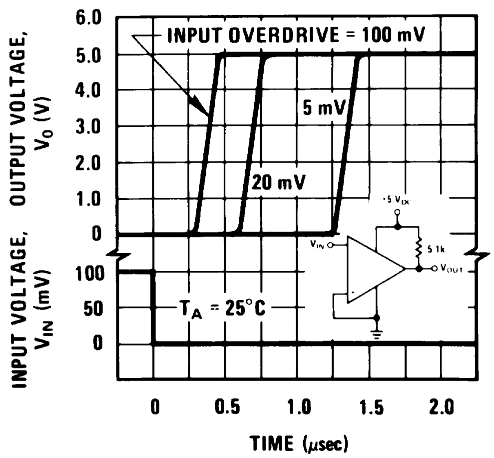


Figure 5.

APPLICATION HINTS

The LM2901EP 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 this input resistors to < 10 kΩ 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 LM2901EP series establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2 V_{DC} to 30 V_{DC}.

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

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

The output of the LM2901EP 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 LM2901EP 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 60Ω 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 V_{DC})

The LM139 within this data sheet's graphics is referenced because of it's a similarity to the LM2901, however is not offered in this data sheet.

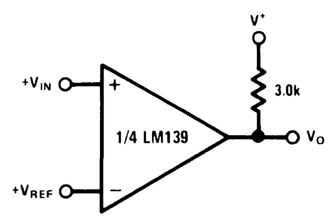


Figure 6. Basic Comparator

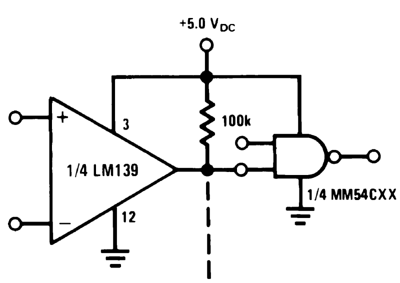


Figure 7. Driving CMOS

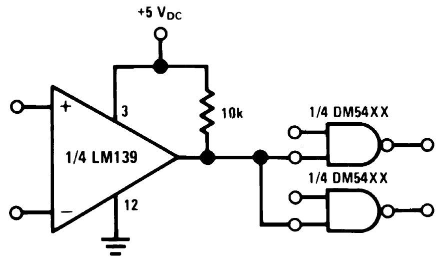


Figure 8. Driving TTL

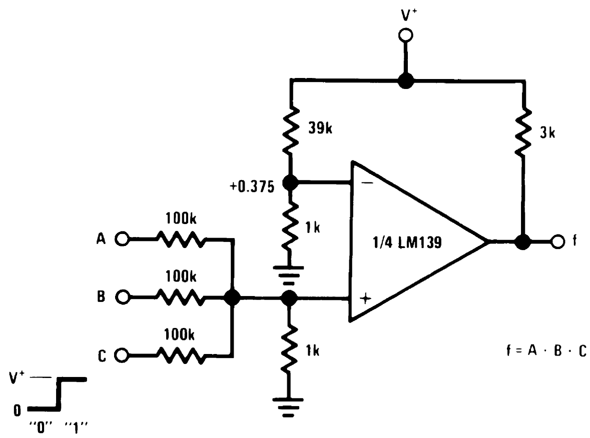


Figure 9. AND Gate

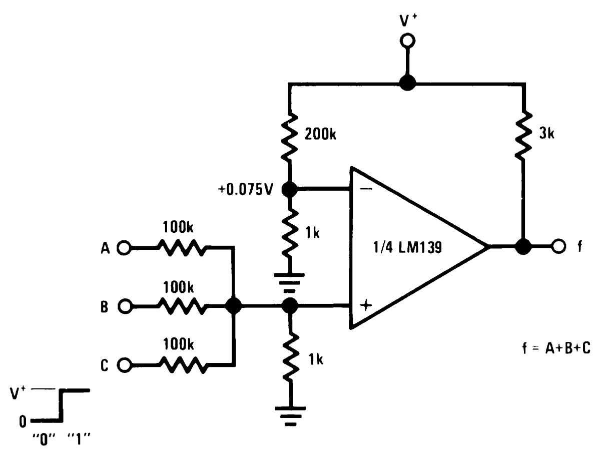


Figure 10. OR Gate

Typical Applications

(V^{+}= 15 V_{DC})

The LM139 within this data sheet's graphics is referenced because of it's a similarity to the LM2901, however is not offered in this data sheet.

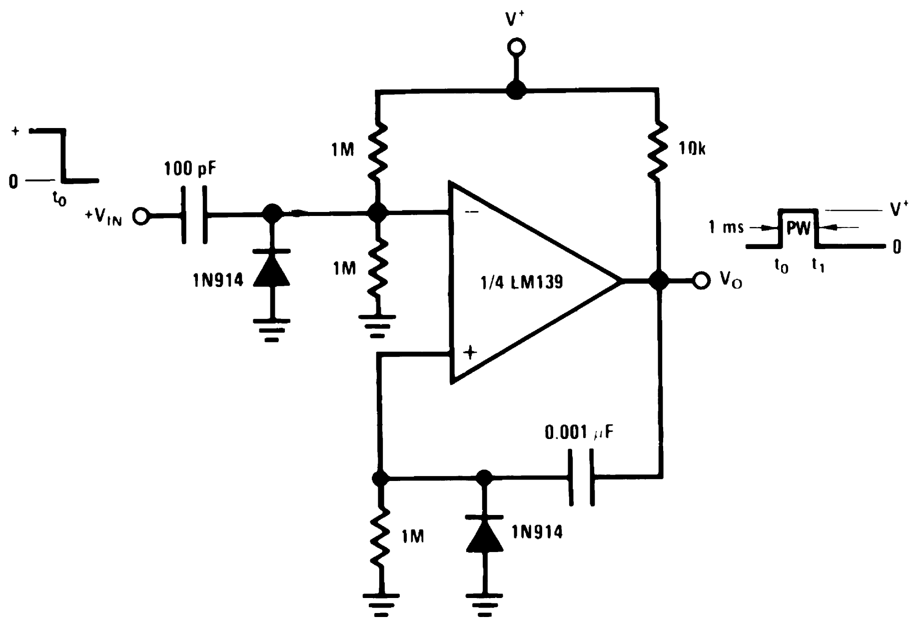


Figure 11. One-Shot Multivibrator

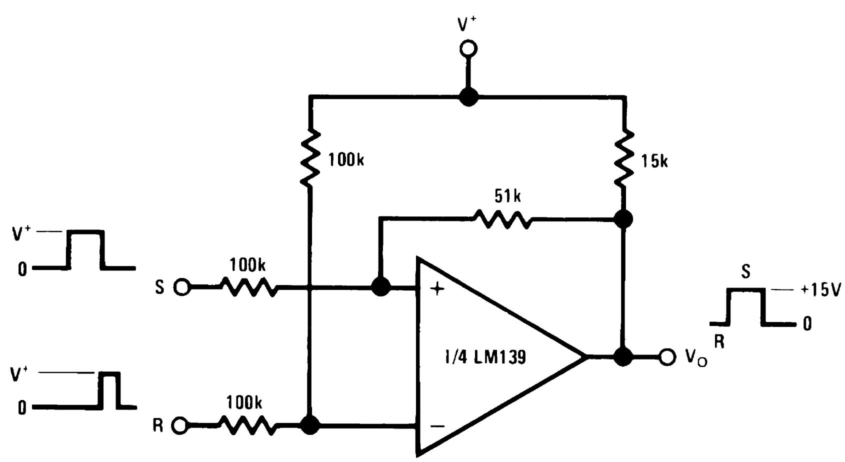


Figure 12. Bi-Stable Multivibrator

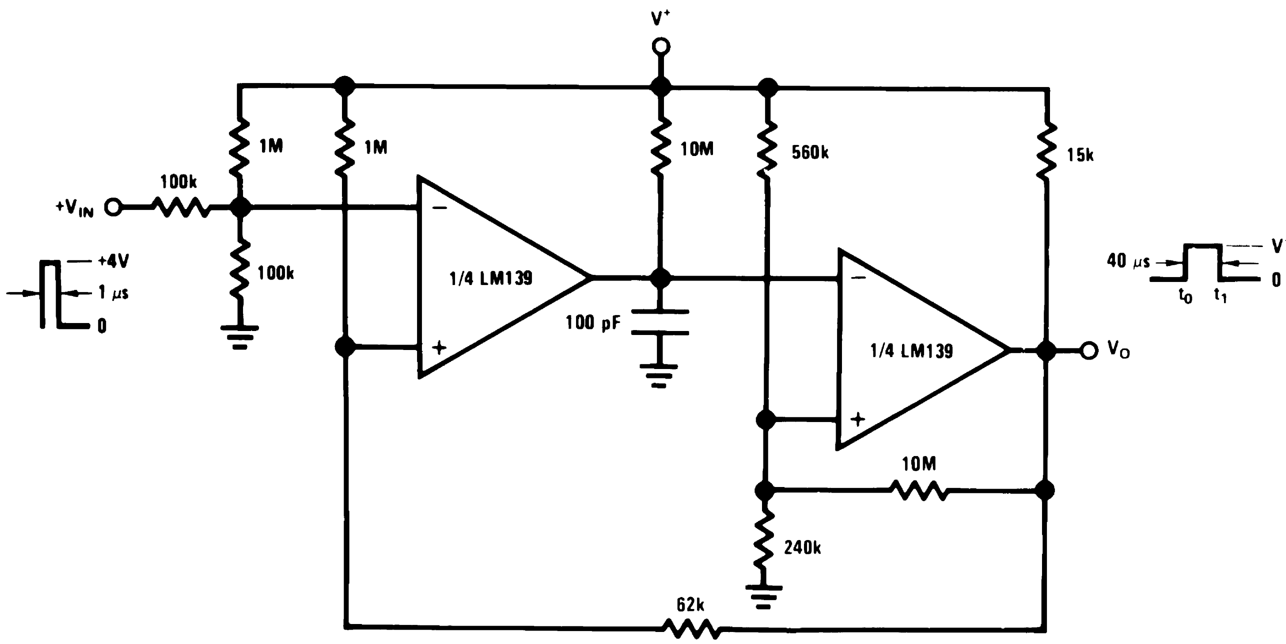


Figure 13. One-Shot Multivibrator with Input Lock Out

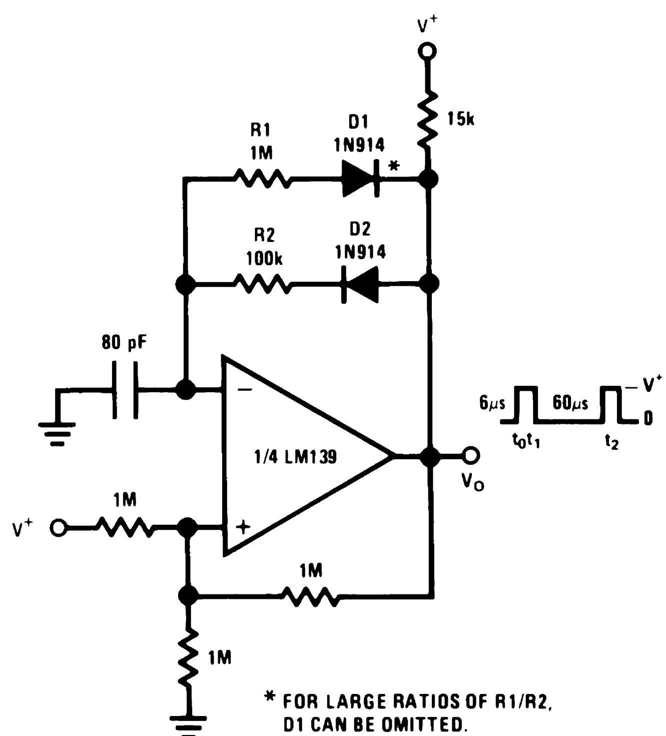


Figure 14. Pulse Generator

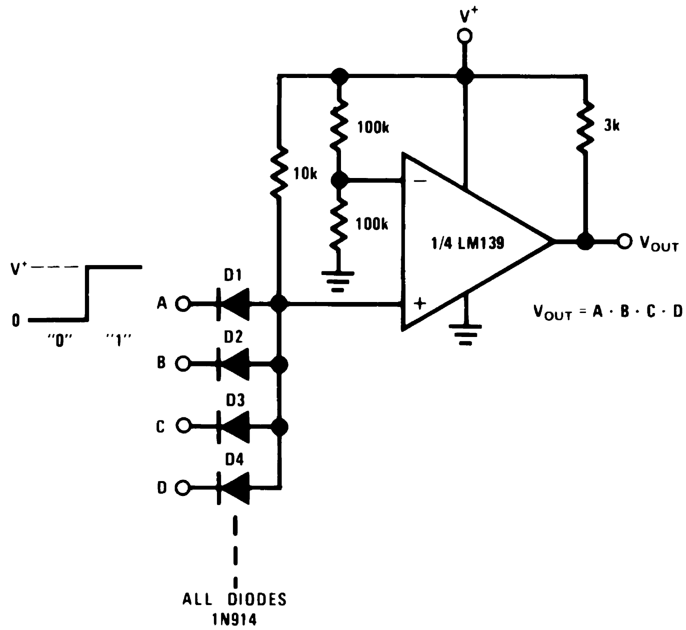


Figure 15. Large Fan-In AND Gate

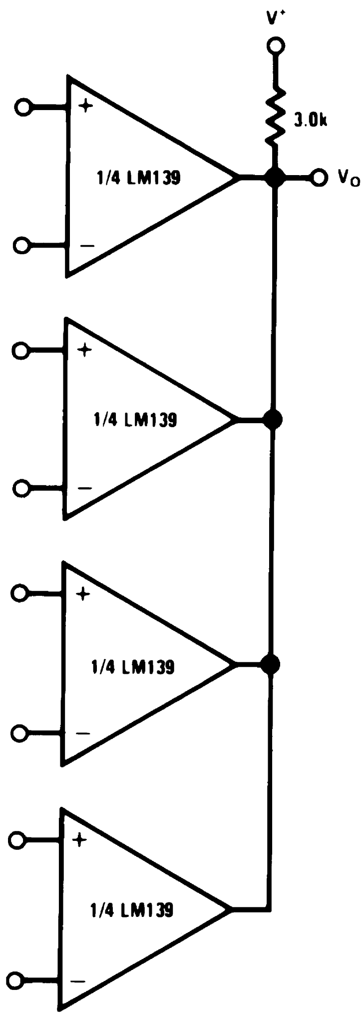


Figure 16. ORing the Outputs

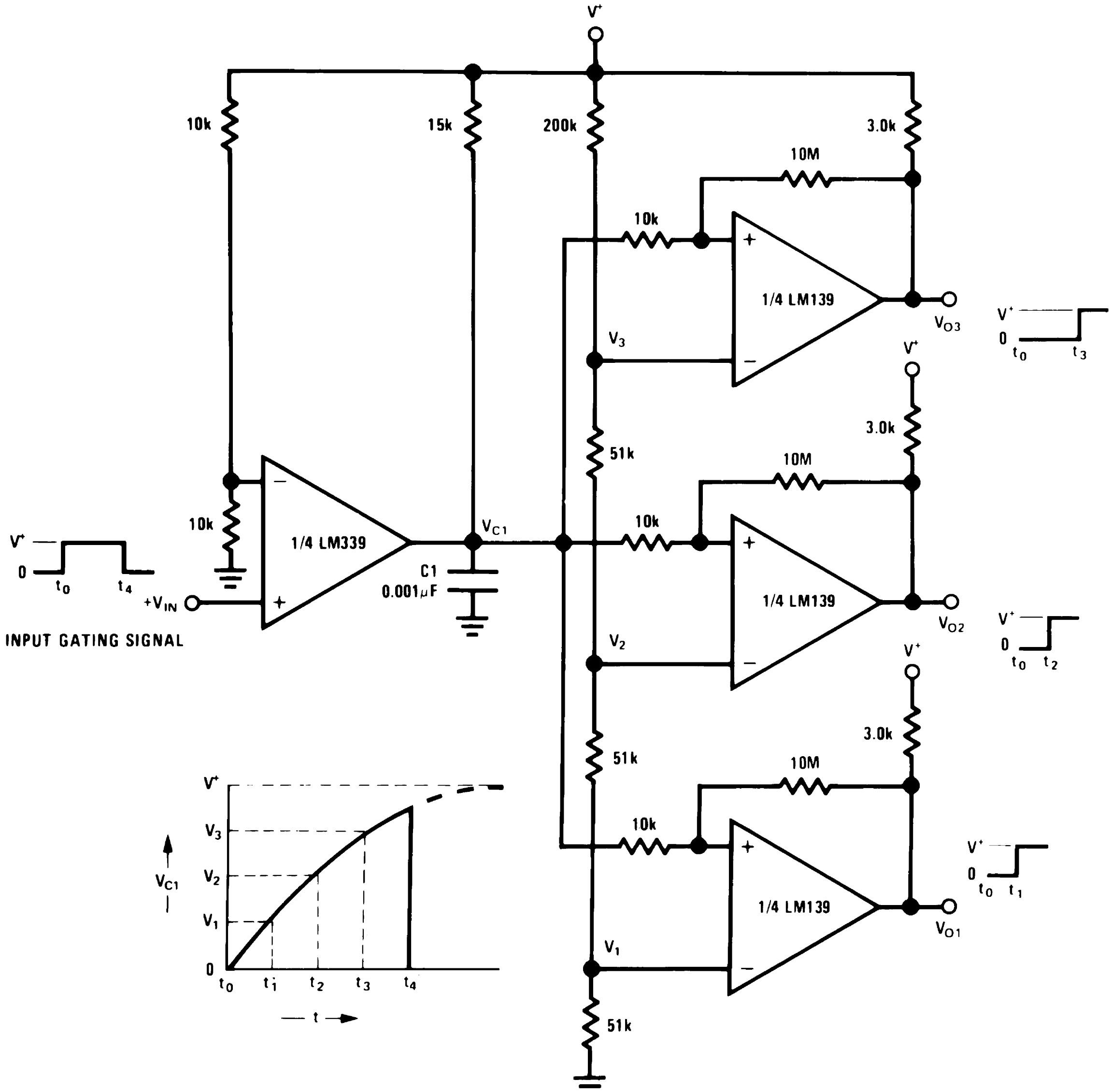


Figure 17. Time Delay Generator

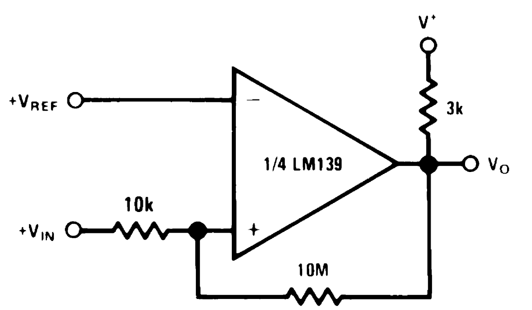


Figure 18. Non-Inverting Comparator with Hysteresis

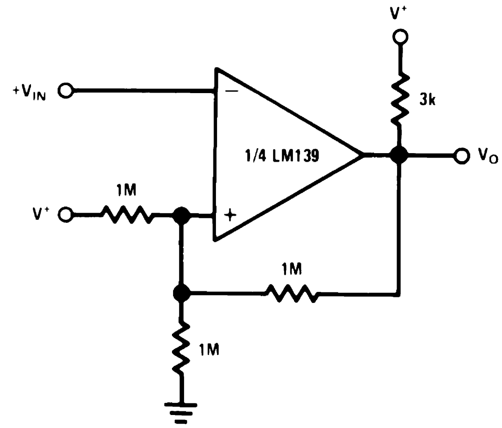


Figure 19. Inverting Comparator with Hysteresis

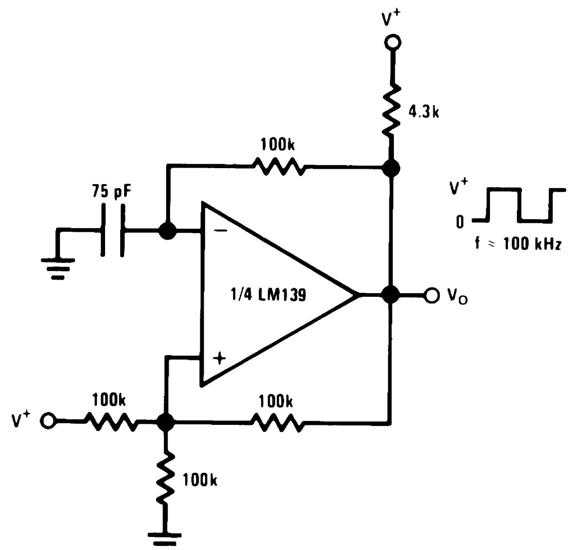


Figure 20. Squarewave Oscillator

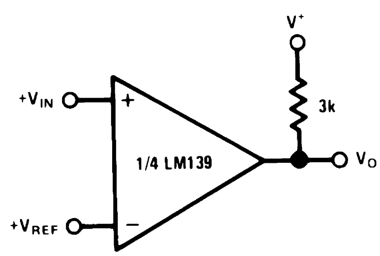


Figure 21. Basic Comparator

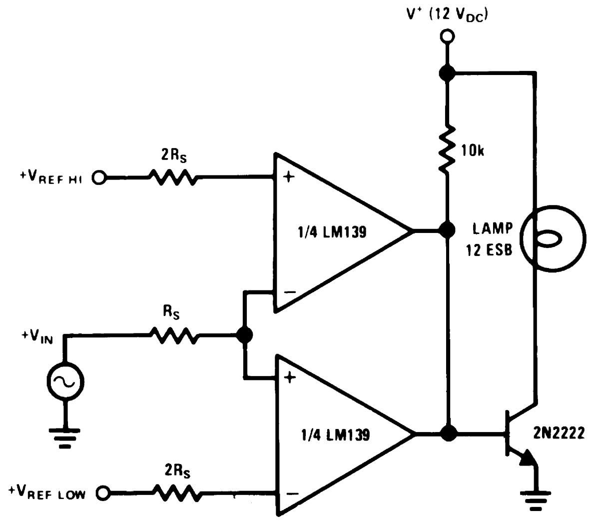


Figure 22. Limit Comparator

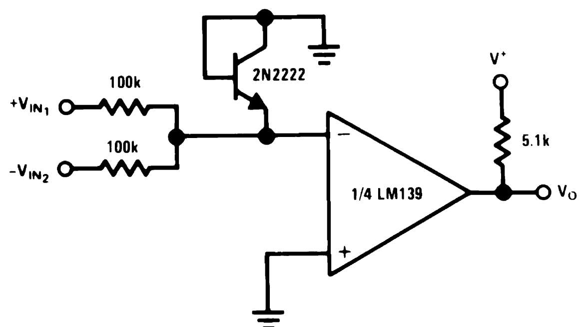
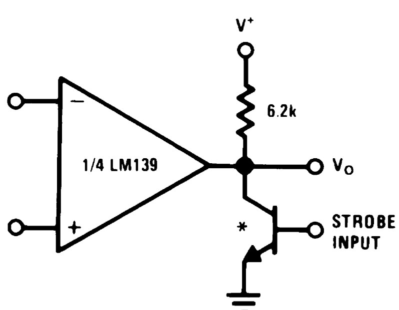


Figure 23. Comparing Input Voltages of Opposite Polarity



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

Figure 24. Output Strobing

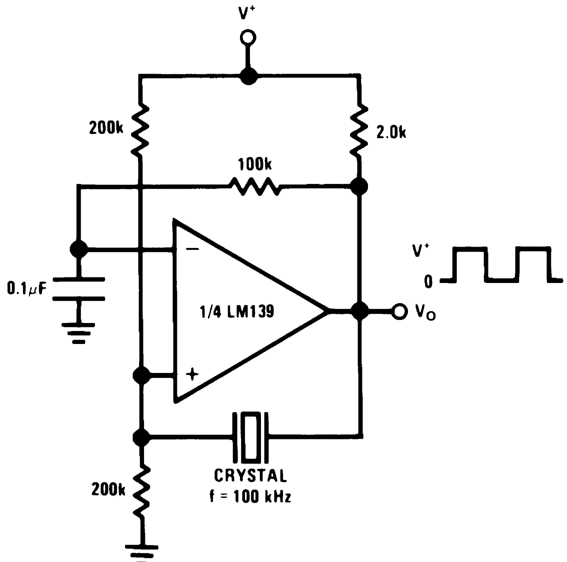
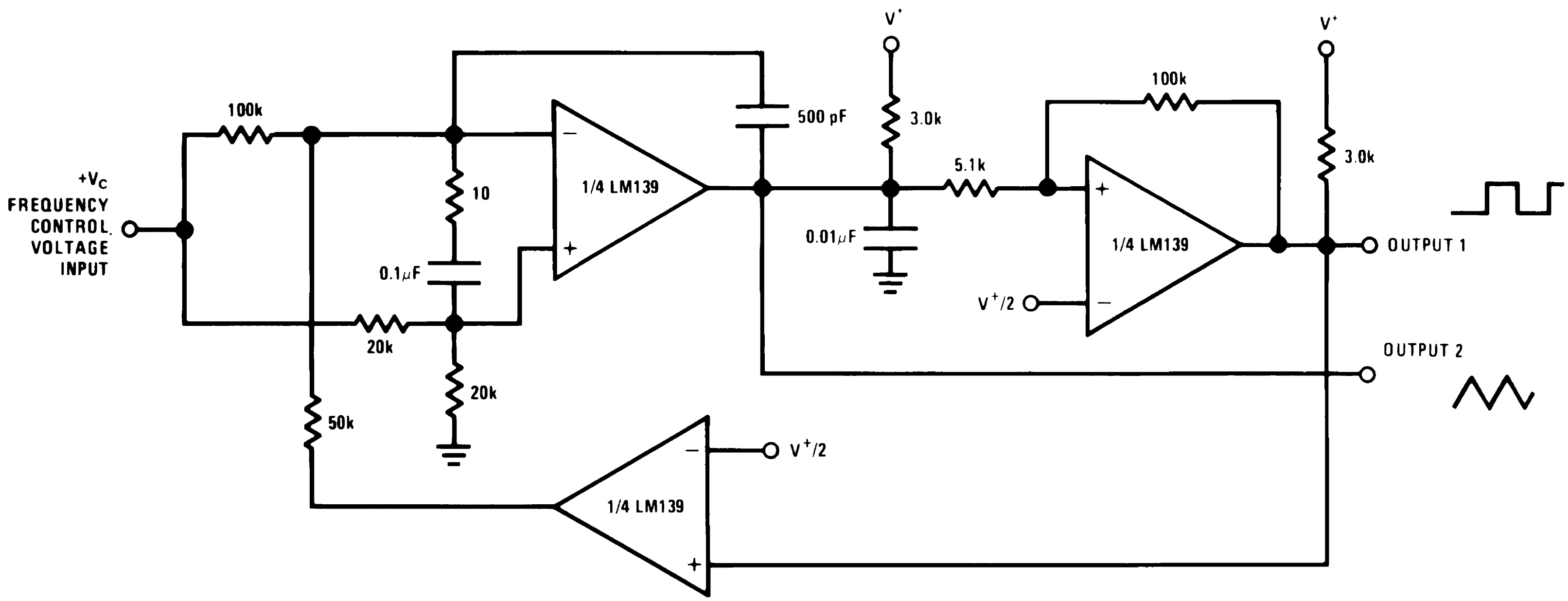


Figure 25. Crystal Controlled Oscillator



$V^+ = +30\ V_{DC}$
$250\ mV_{DC} \leq V_C \leq +50\ V_{DC}$
$700\ Hz \leq f_O \leq 100\ kHz$

Figure 26. Two-Decade High-Frequency VCO

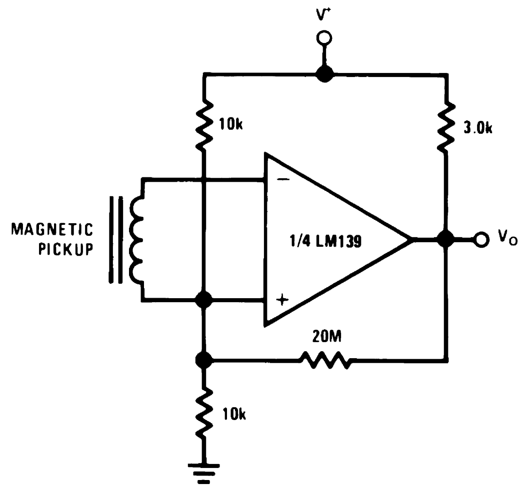


Figure 27. Transducer Amplifier

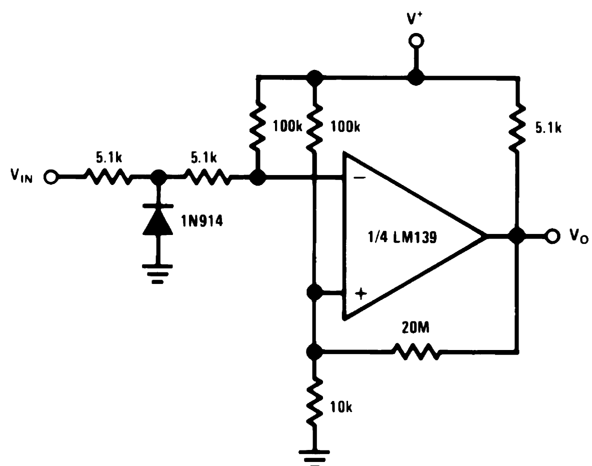


Figure 28. Zero Crossing Detector (Single Power Supply)

Split-Supply Applications

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

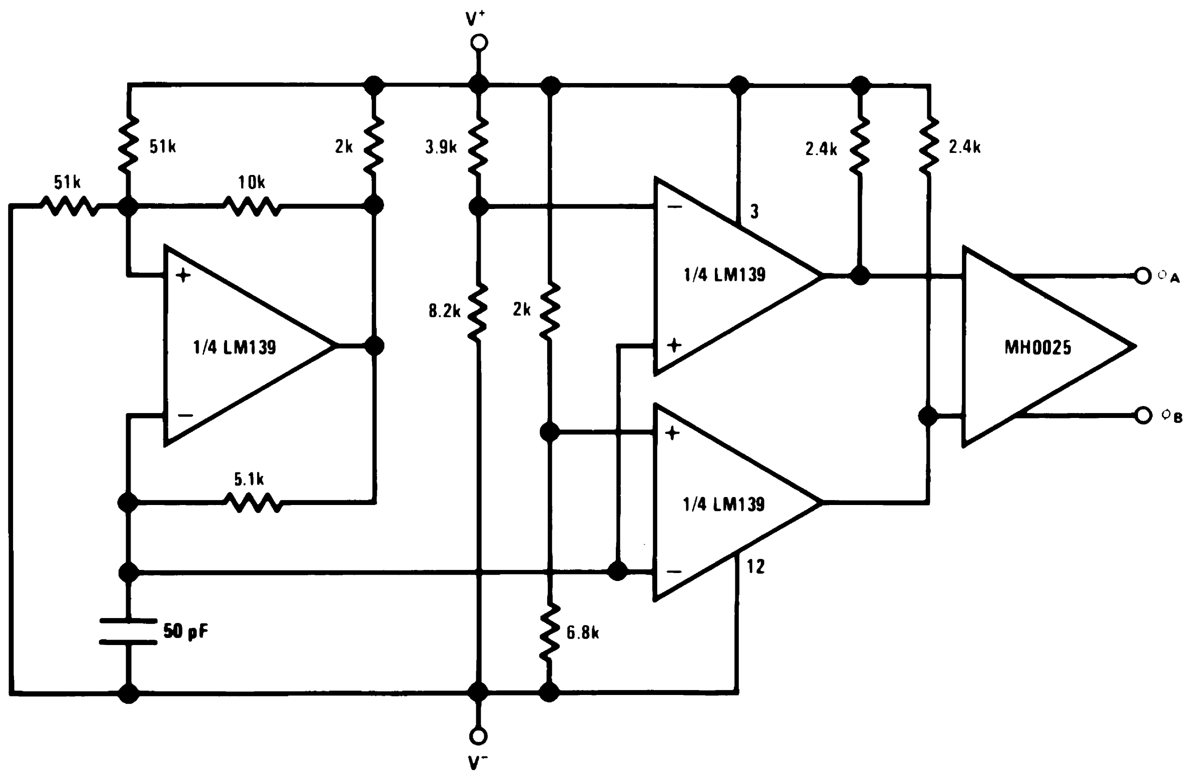


Figure 29. MOS Clock Driver

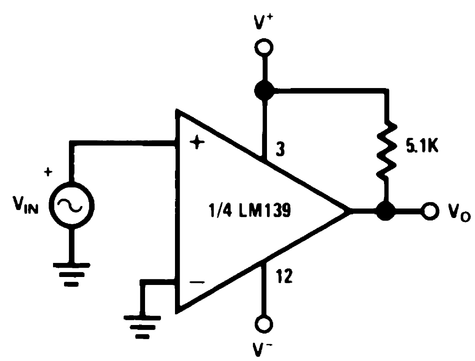


Figure 30. Zero Crossing Detector

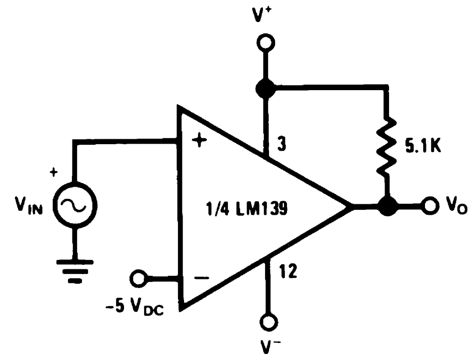
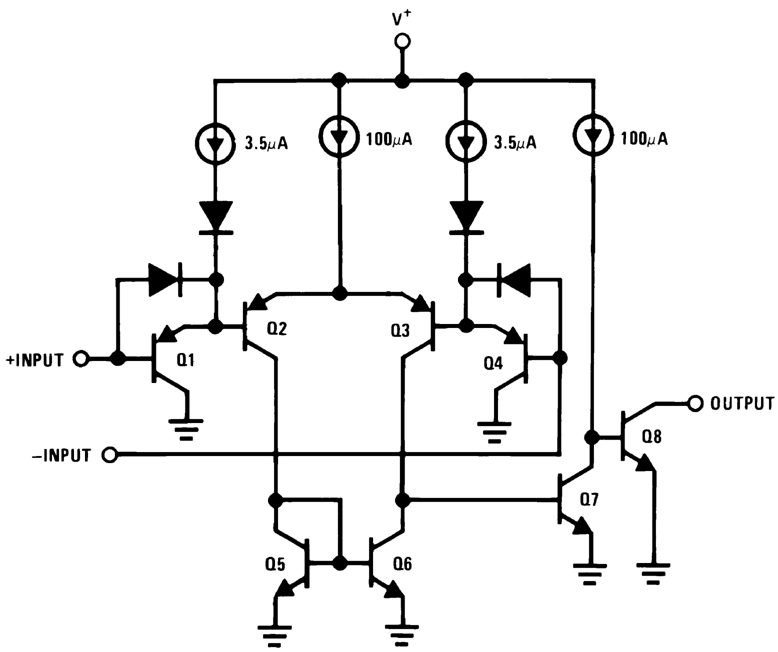
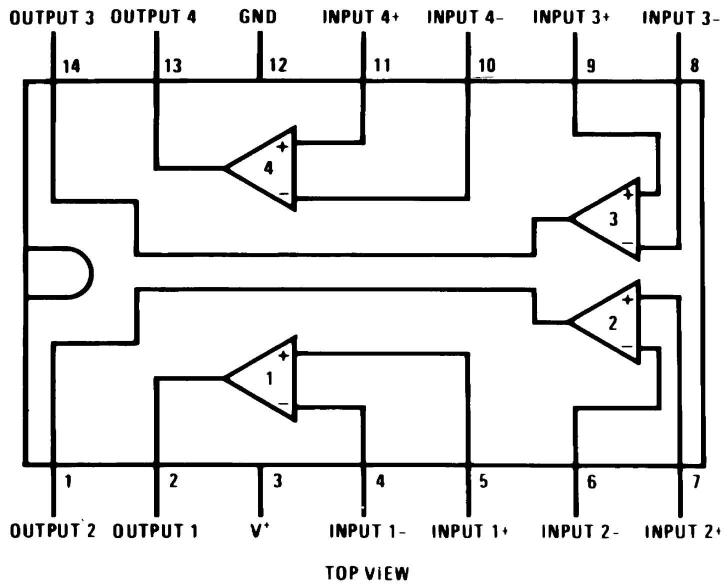


Figure 31. Comparator With a Negative Reference

Schematic Diagram



Connection Diagrams



Dual-In-Line Package - SOIC/PDIP
See Package Number D and NFF

REVISION HISTORY

Changes from Revision A (April 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	20

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM2901 MWA	ACTIVE	WAFERSALE	YS	0	1	RoHS & Green	Call TI	Level-1-NA-UNLIM	-40 to 85		Samples

[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] **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

[3] MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

[4] There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

[5] Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

[6] Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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.

IMPORTANT NOTICE AND DISCLAIMER