



# Voltage Comparators/Buffers

## LM311 voltage comparator

### general description

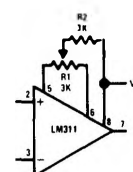
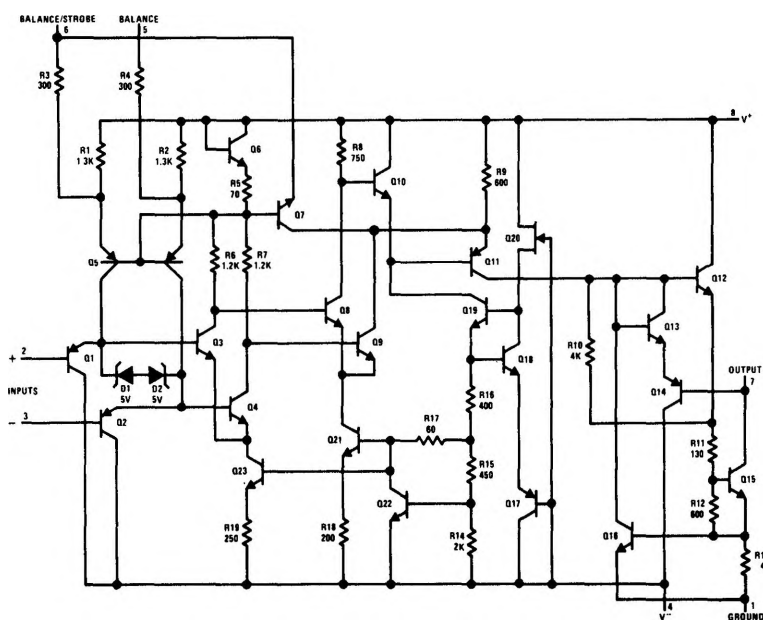
The LM311 is a voltage comparator that has input currents more than a hundred times lower than devices like the LM306 or LM710C. It is also designed to operate over a wider range of supply voltages: from standard  $\pm 15V$  op amp supplies down to the single 5V supply used for IC logic. Its output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, it can drive lamps or relays, switching voltages up to 40V at currents as high as 50 mA. Outstanding characteristics include:

- Operates from single 5V supply
- Maximum input current: 250 nA
- Maximum offset current: 50 nA

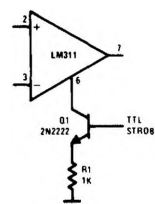
- Differential input voltage range:  $\pm 30V$
- Power consumption: 135 mW at  $\pm 15V$

Both the input and the output of the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR'ed. Although slower than the LM306 and LM710C (200 ns response time vs 40 ns) the device is also much less prone to spurious oscillations. The LM311 has the same pin configuration as the LM306 and LM710C.

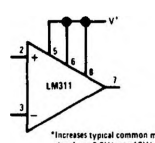
## schematic diagram and auxiliary circuits



Offset Balancing

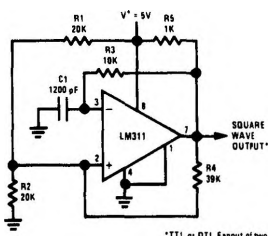


Strobing

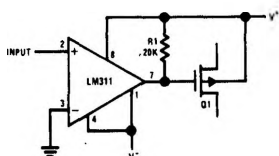


Increasing Input Stage Current\*

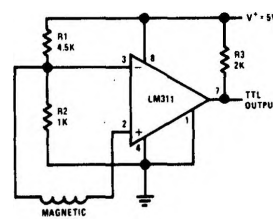
## typical applications



100 kHz Free Running Multivibrator



Zero Crossing Detector Driving MOS Switch



Detector for Magnetic Transducer

**absolute maximum ratings**

Total Supply Voltage ( $V_{84}$ )	36V
Output to Negative Supply Voltage ( $V_{74}$ )	40V
Ground to Negative Supply Voltage ( $V_{14}$ )	30V
Differential Input Voltage	$\pm 30V$
Input Voltage (Note 1)	$\pm 15V$
Power Dissipation (Note 2)	500 mW
Output Short Circuit Duration	10 sec
Operating Temperature Range	$0^{\circ}C$ to $70^{\circ}C$
Storage Temperature Range	$-65^{\circ}C$ to $150^{\circ}C$
Lead Temperature (soldering, 10 sec)	$300^{\circ}C$

**electrical characteristics** (Note 3)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage (Note 4)	$T_A = 25^{\circ}C$ , $R_S \leq 50K$		2.0	7.5	mV
Input Offset Current (Note 4)	$T_A = 25^{\circ}C$		6.0	50	nA
Input Bias Current	$T_A = 25^{\circ}C$		100	250	nA
Voltage Gain	$T_A = 25^{\circ}C$		200		V/mV
Response Time (Note 5)	$T_A = 25^{\circ}C$		200		ns
Saturation Voltage	$V_{IN} \leq -10$ mV, $I_{OUT} = 50$ mA $T_A = 25^{\circ}C$		0.75	1.5	V
Strobe On Current	$T_A = 25^{\circ}C$		3.0		mA
Output Leakage Current	$V_{IN} \geq 10$ mV, $V_{OUT} = 35V$ $T_A = 25^{\circ}C$		0.2	50	nA
Input Offset Voltage (Note 4)	$R_S \leq 50K$			10	mV
Input Offset Current (Note 4)				70	nA
Input Bias Current				300	nA
Input Voltage Range			$\pm 14$		V
Saturation Voltage	$V^+ \geq 4.5V$ , $V^- = 0$ $V_{IN} \leq -10$ mV, $I_{SINK} \leq 8$ mA		0.23	0.4	V
Positive Supply Current	$T_A = 25^{\circ}C$		5.1	7.5	mA
Negative Supply Current	$T_A = 25^{\circ}C$		4.1	5.0	mA

**Note 1:** This rating applies for  $\pm 15V$  supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

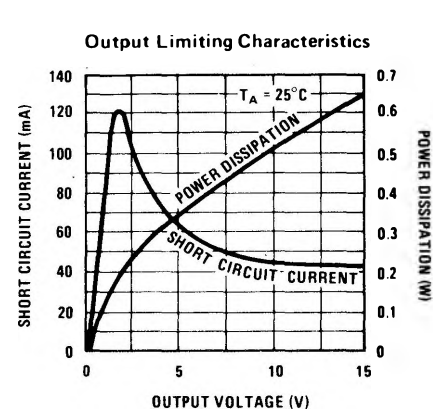
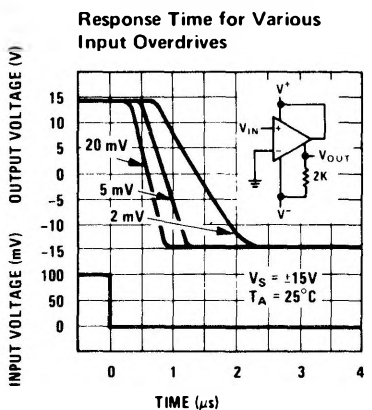
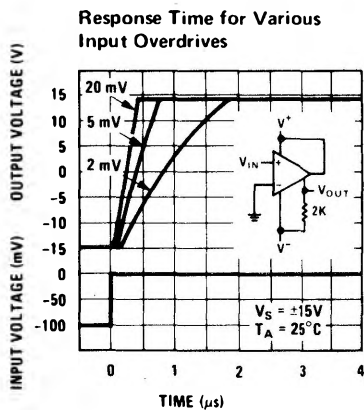
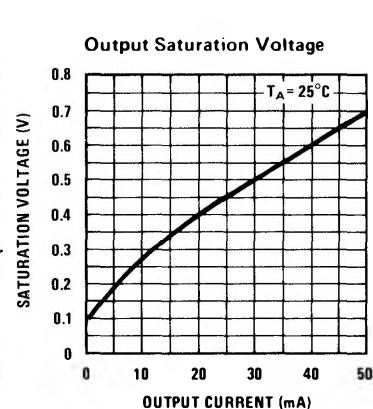
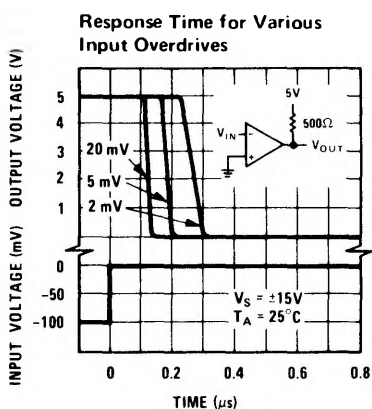
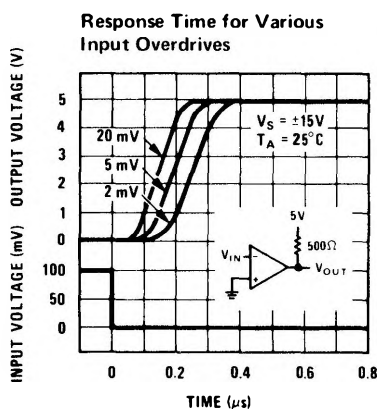
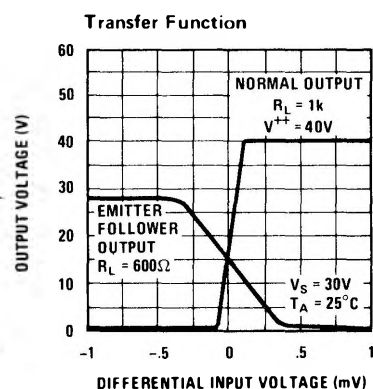
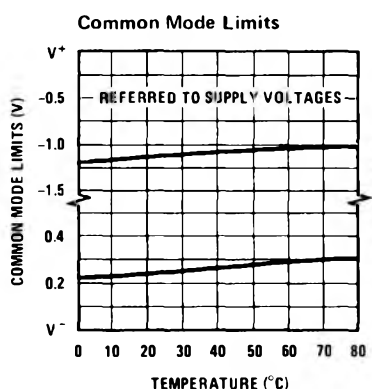
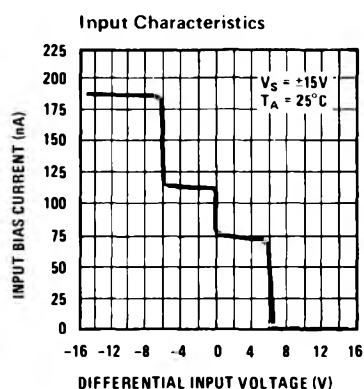
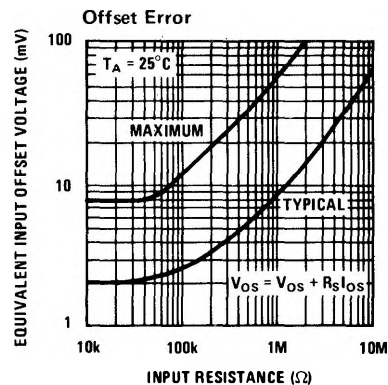
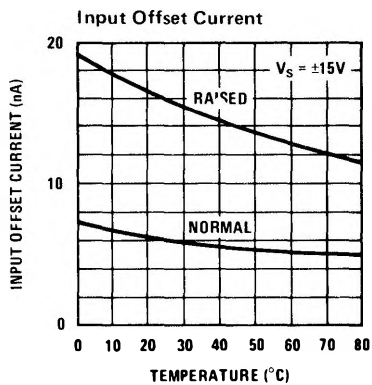
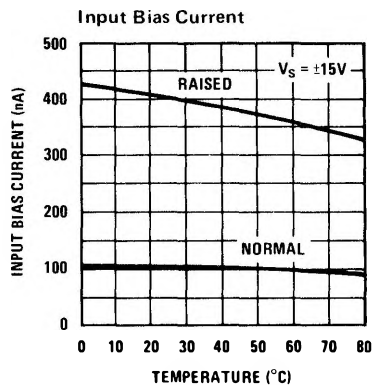
**Note 2:** The maximum junction temperature of the LM311 is  $85^{\circ}C$ . For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of  $150^{\circ}C/W$ , junction to ambient, or  $45^{\circ}C/W$ , junction to case. For the flat package, the derating is based on a thermal resistance of  $185^{\circ}C/W$  when mounted on a 1/16-inch-thick epoxy glass board with ten, 0.03-inch-wide, 2-ounce copper conductors. The thermal resistance of the dual-in-line package is  $100^{\circ}C/W$ , junction to ambient.

**Note 3:** These specifications apply for  $V_S = \pm 15V$  and  $0^{\circ}C < T_A < 70^{\circ}C$ , unless otherwise specified. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to  $\pm 15V$  supplies.

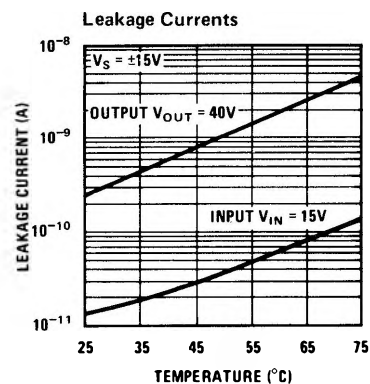
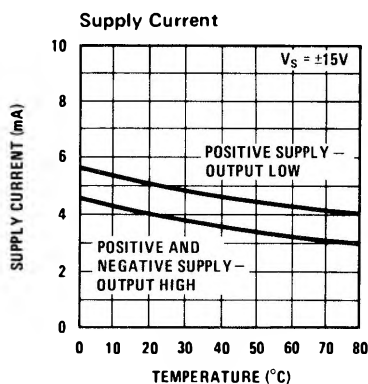
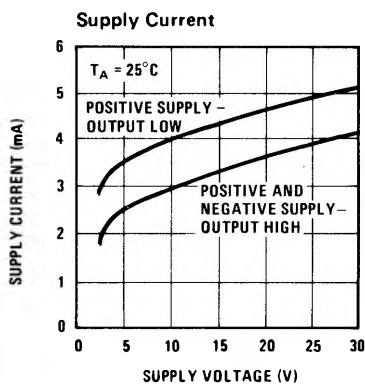
**Note 4:** The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.

**Note 5:** The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.

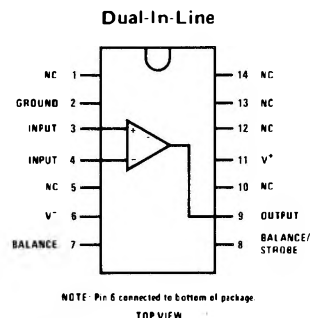
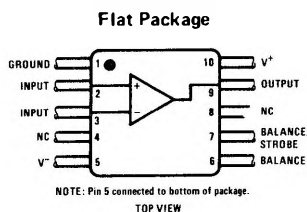
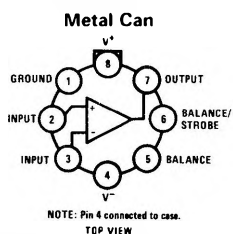
## typical performance



## typical performance

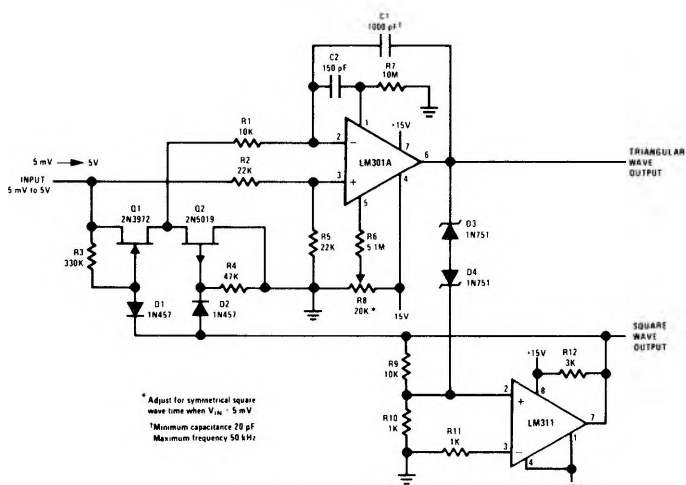


## connection diagrams \*

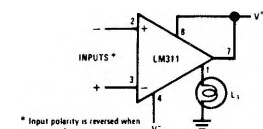


**\*Pin connections shown on schematic diagram and typical applications are for TO-5 package.**

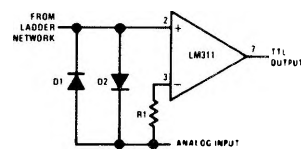
## typical applications



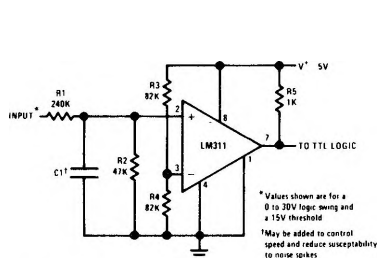
### 10 Hz to 10 kHz Voltage Controlled Oscillator



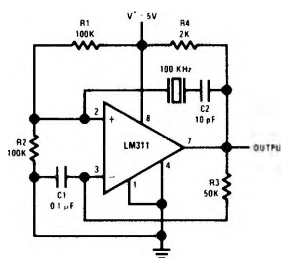
### Driving Ground-Referenced Load



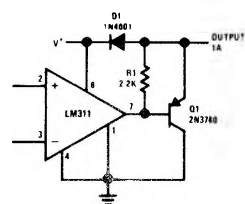
## Using Clamp Diodes to Improve Response



### TTL Interface with High Level Logic

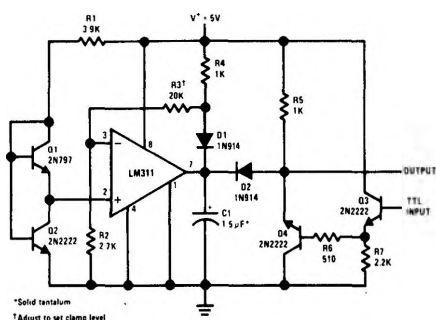


### Crystal Oscillator

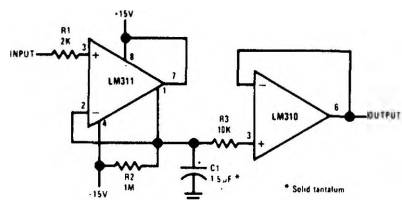


### Comparator and Solenoid Driver

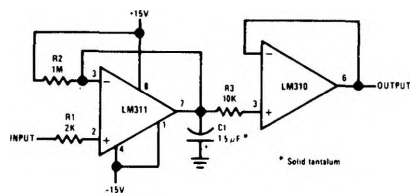
## typical applications



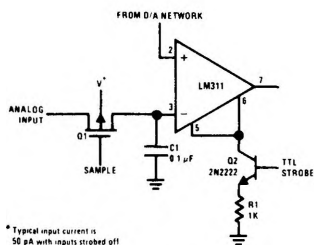
### Precision Squarer



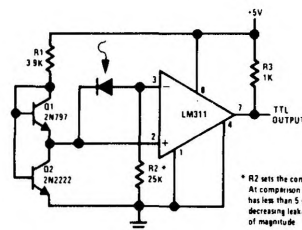
### Positive Peak Detector



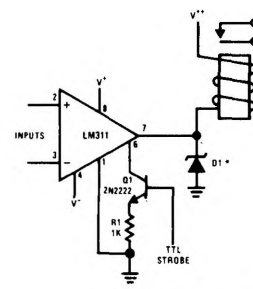
### Negative Peak Dectector



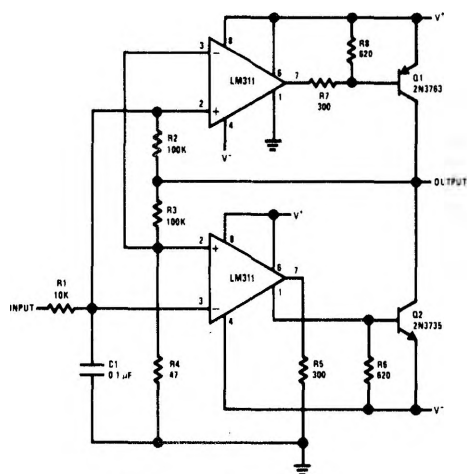
### Strobing off Both Input\* and Output Stages



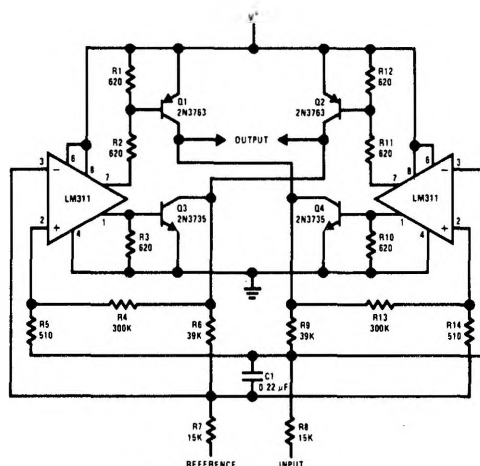
### Precision Photodiode Comparator



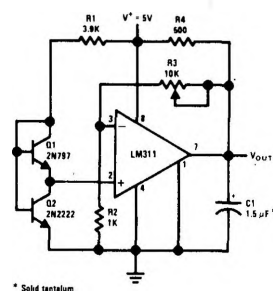
### Relay Driver with Strobe



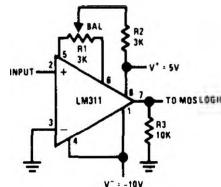
### Switching Power Amplifier



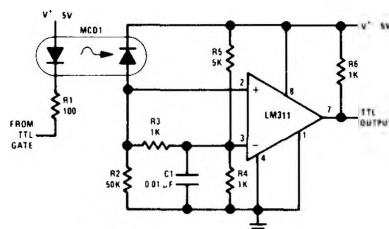
### Switching Power Amplifier



### Low Voltage Adjustable Reference Supply



### Zero Crossing Detector driving MOS logic



### Digital Transmission Isolator