Lab 04: Basic OPAMP Circuit: Nonlinear

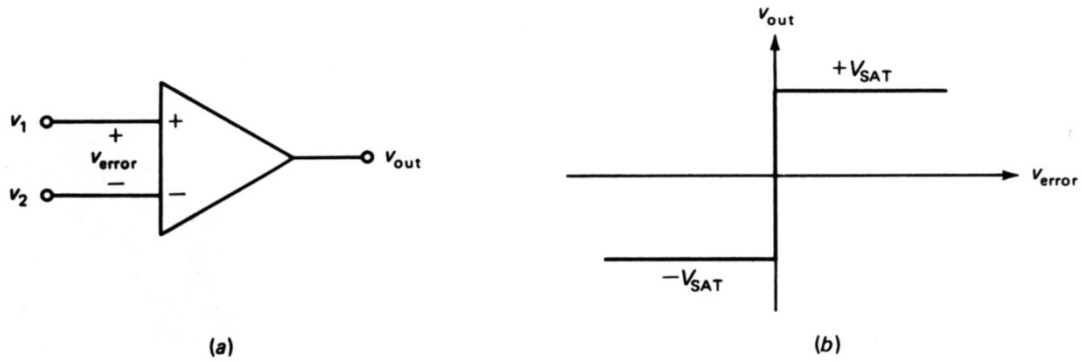
【Purpose】

Build nonlinear circuit including comparator, rectifier and peak detector

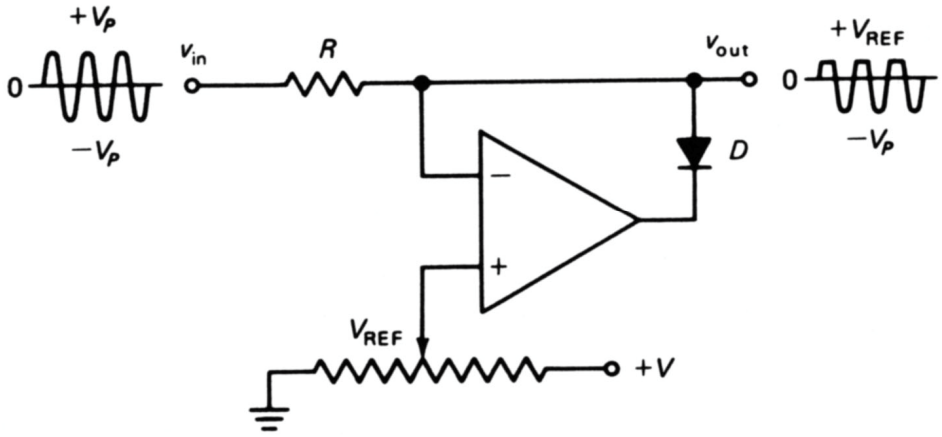
【Theory】

Non-linear OPAMP circuit: Voltage amplifier

Because the high open loop gain of OP amp, the slightest error voltage between inputs (V_1-V_2) can produce maximum output swing. For instance, if the output voltage is 0.7V and open loop gain is 100000, the input V_{error} is only 7 uV. This means a slight higher V_1 than V_2 gives positive V_{error} and this drive output voltage goes to +V_{SAT} (usually 15V). Then a negative V_{error} drives the output voltage to -V_{SAT} (usually 15V). This can be as comparator because all it can do is compare V_1 to V_2.

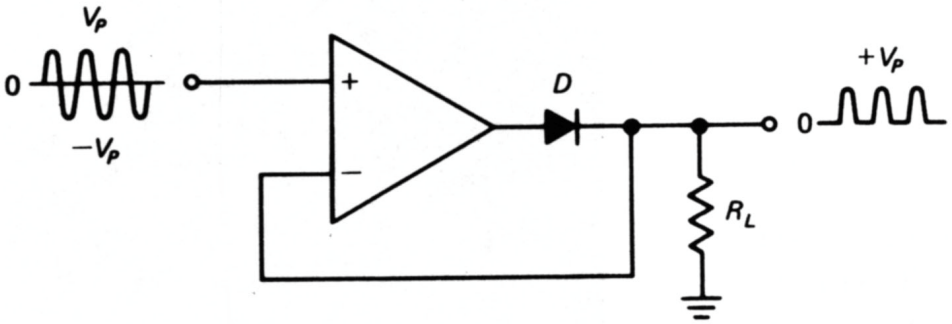


For active positive limiter (also called a “clipper”), when V_{in} (V-) is higher than V_{ref} (V+), the error voltage drives the op amp output to negative (-Vcc) and turn on the diode. This means the V_{out} is same as V_{ref} for any V_{in} over V_{ref}. When V_{in} (V-) is lower than V_{ref} (V+), the error voltage drives the op amp output to positive (+Vcc) and turn off the diode. The V_{out} follows the V_{in} for any V_{in} smaller than V_{ref}.

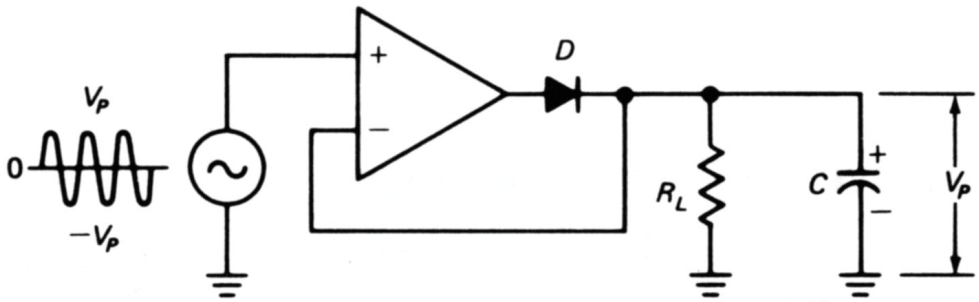


active positive limiter (clipper)

For rectifier, when input signal goes positive, the output goes positive and turns on the diode. The circuit then acts like a voltage follower, input and output have the same waveform in the positive half cycle. On the other hand, when the input goes negative, the op amp output goes negative and turns off the diode. Since the diode is open, no voltage appears across the R_L. Then output is 0 in the negative half cycle. This is why final output looks like a perfect half-wave signal. When there is a capacitor in parallel to the R_L, the capacitor charge to the peak input voltage during positive half cycle. This is then called a peak-detector.



rectifier



peak detector

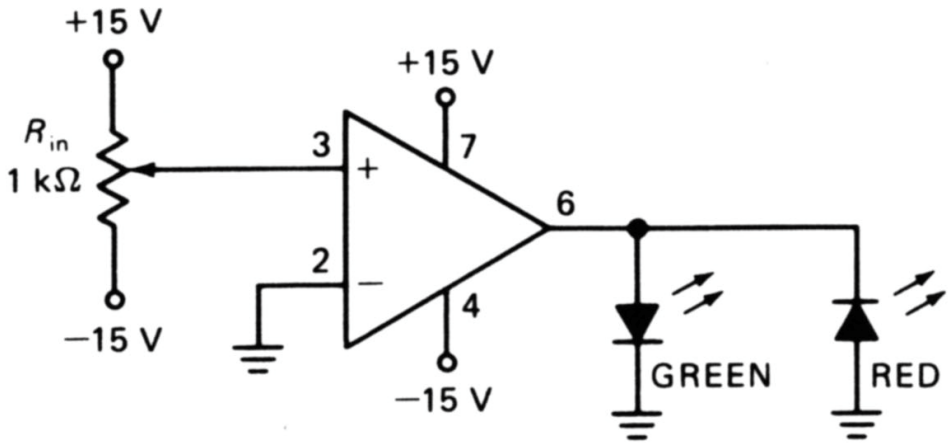
【Instrument】

Oscilloscope(示波器)、Function generator(訊號產生器)、Power supply(電源供應器)、Resistor (2.2KΩ, 10KΩ)、Potentiometer (可變電阻, 1KΩ)、Capacitor (1uF, 10uF, 100 uF)、OPAMP (ua741C)、LED (發光二極體) x2

【Steps】

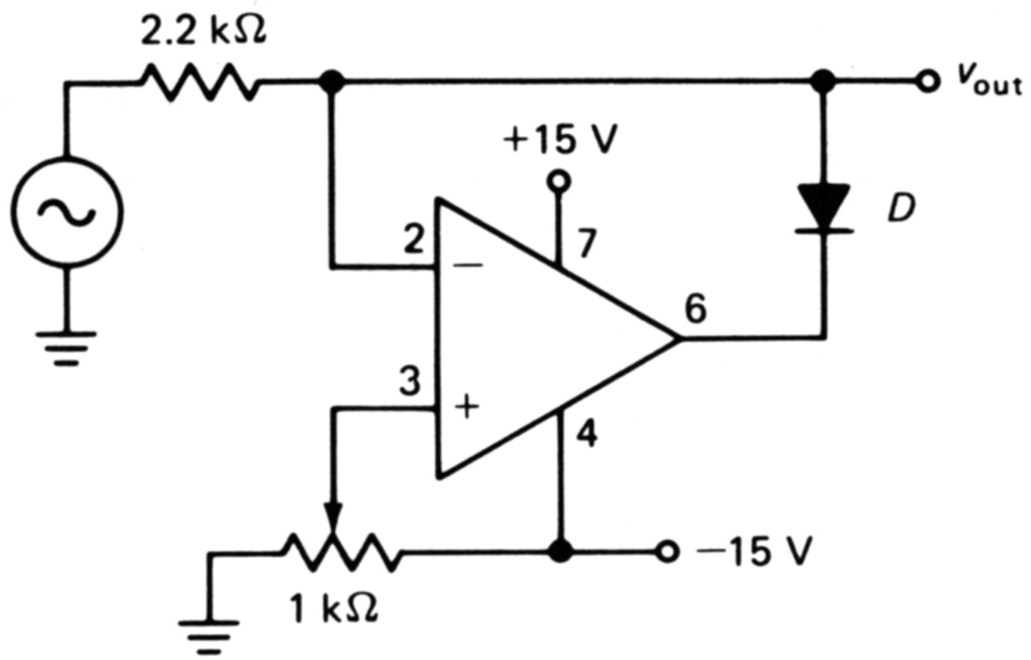
Comparator

1. Connect the circuit.
2. Vary R_{in} and observe what the LED do.
3. Using DC mode of the oscilloscope to look at the input voltage (pin3). Adjust R_{in} to get 100 mV and -100 mV and record the color of LED. If possible, try to find the voltage when color of LED switch.
4. Connect a function generator to input voltage (pin3) and adjust the frequency until you can observe red and green LED flicker



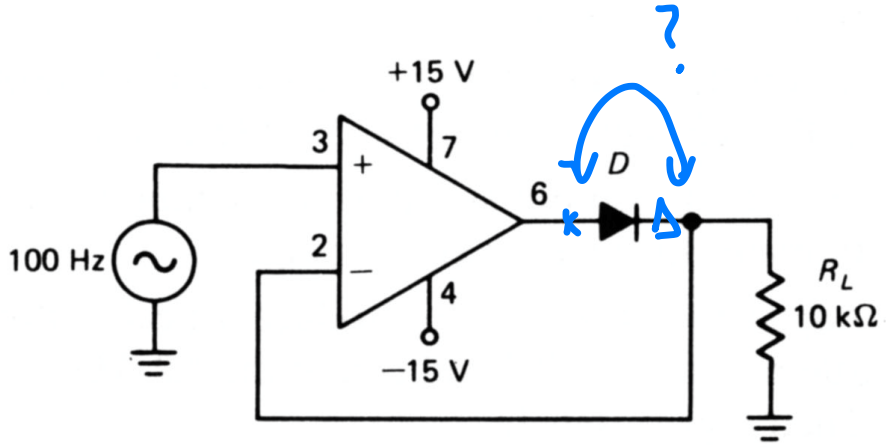
Active Limiter

1. Connect the circuit.
2. Adjust the function generator to produce a peak value of 1V at the left hand of 2.2 KΩ.
3. Observe the output voltage while turning the potential meter through entire range. Choose one waveform and record the waveform and voltage of pin3. sinusoidal wave, -5 V



Half-wave rectifier and Peak detector

1. Connect the circuit.
2. Set AC generator at 100Hz. Adjust signal level to get a peak of 1V input sine wave (pin3). Record the waveform and peak value of the output voltage in the table. This should be a half wave signal.
3. Connect a 100 uF capacitor across R_L in the circuit. Recode the waveform and peak value of output voltage (voltage across C).
4. Connect a 10 uF capacitor across R_L in the circuit. Recode the waveform and peak value of output voltage (voltage across C).
5. Connect a 1 uF capacitor across R_L in the circuit. Recode the waveform and peak value of output voltage (voltage across C).



【Questions】

1. For comparator, if pin2 is connected to a DC source of 1.5V, what voltage for pin3 will you observe the crossover for red and green LED
2. For half-wave rectifier, If the diode is reverse, what would the output be for an input sine wave with a peak of 100 mV? 5V
3. Describe the output of peak detector if the diode is reversed.

【Supplement】

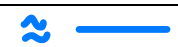
Table 1 Comparator

Color (100 mV)	
Color (-100 mV)	
Flicker frequency	

Table 2 **Active Limiter**

$V_{in\text{-}p}$	$V_{in\text{-}freq}$	$V_{(pin3)}$	V_{out} waveform
1V	1KHz	-5V	Sinusoidal wave

Table 3 Half-wave rectifier and Peak detector

	$V_{in\text{-}p}$	$V_{out\text{-}p}$	V_{out} waveform
Step2	1V, 100 Hz		
Step3-100uF	1V, 100 Hz	1.1V	
Step4-10 uF	1V, 100 Hz		
Step5-1 uF	1V, 100 Hz