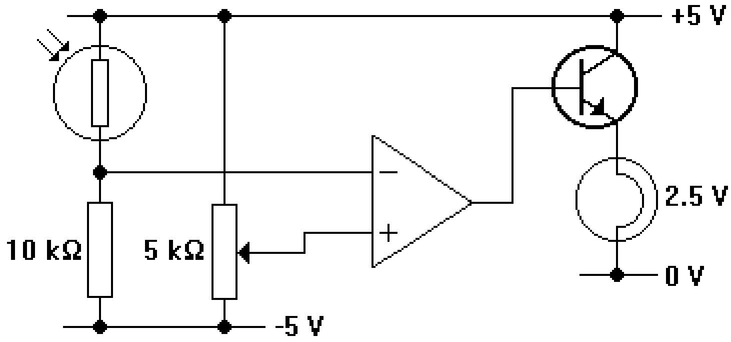
Light control

This experiment will help you to appreciate the finer points of servo control systems.

1 Assemble the on-off feedback system shown below. Use a power transistor to drive a bulb rated at 2.5 V. Arrange for the bulb to be close to the LDR.



2 If all is well, the brightness of the lamp should depend on the setting of the potentiometer.

3 Use an oscilloscope to look at the output of the op-amp. Notice how the signal changes as you adjust the potentiometer. Explain the shape of the signal.

4 Modify the circuit so that it becomes a proportional feedback system. Use 1 M and 100 nF in the ramp generator. Four 47 k resistors will be fine for the difference amplifier. Make sure that the feedback is negative and not positive!

5 Check that the brightness of the bulb follows the setting of the potentiometer.

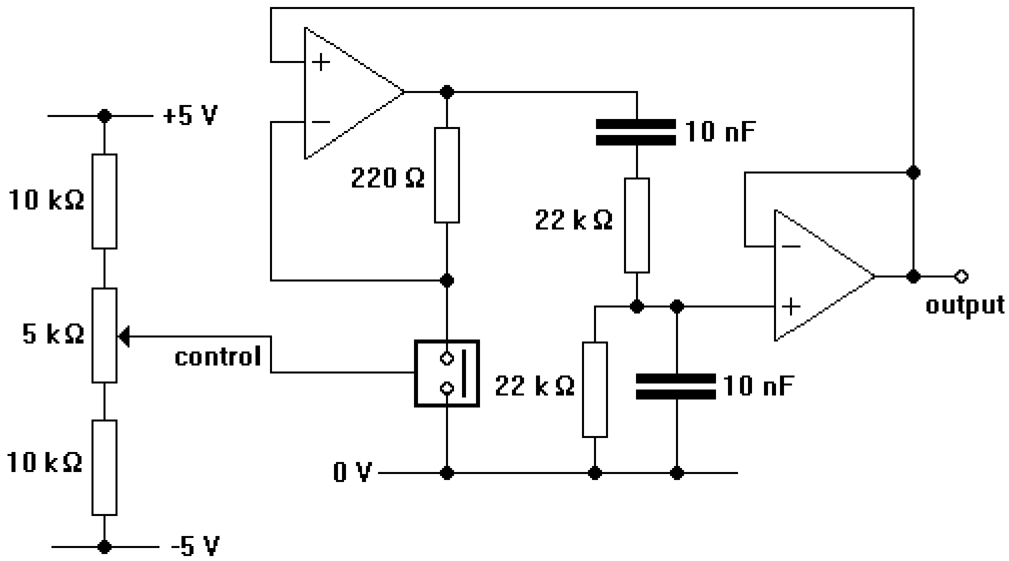
6 Use a double-beam oscilloscope to look at the outputs of the difference amplifier and the ramp generator. Note what they do when the setting of the potentiometer is changed.

7 Speed up the response time of the system by altering the values of components in the ramp generator. See how short you can make the response time before the system starts to hunt.

8 Draw a circuit diagram for the fastest proportional feedback system which works properly. Explain how the circuit works.

A stable sine wave oscillator

1 Assemble the circuit shown below. Use one of the four analogue switches in a 4066 i.c. as the bottom resistor of the non-inverting amplifier. Run the i.c. off supply rails at +5 V and -5 V instead of +5V and 0 V.



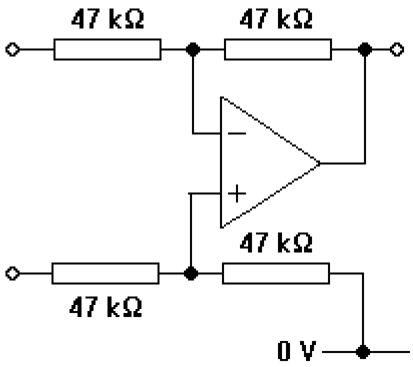
2 Use a double-beam oscilloscope to look at the **output** and **control** terminals of the circuit.

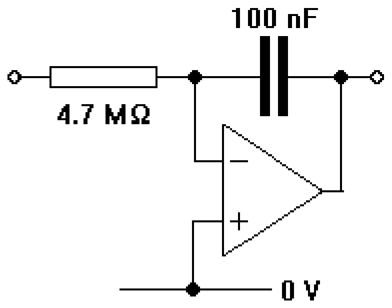
3 Use the potentiometer to set **control** to -1 V. If all is well, the output of the circuit should be a distorted sine wave with a frequency of about 1 kHz.

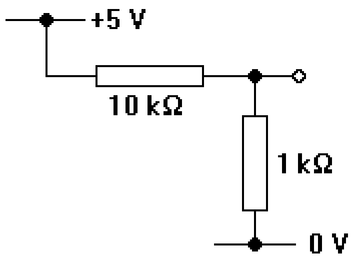
4 Slowly sweep the voltage of the control terminal from -1 V to +1 V. The distortion of the sine wave should reduce and then the sine wave itself will disappear. Only when the control voltage is just right, will the sine wave be undistorted.

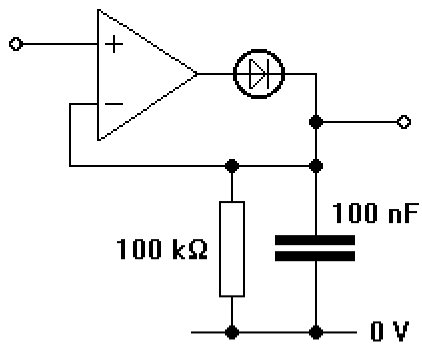
5 Design a proportional feed back system which will automatically adjust the voltage at the control terminal so that the peak voltage of the sine wave at the output is 0.5 V. You will need to use the sub-systems shown below. Make sure that your design uses feedback which is negative and not positive!

6 When you have got the system to produce a stable and undistorted sine wave with a frequency of about 750 Hz, draw its circuit diagram and explain how it works.


47 kΩ
47 kΩ
47 kΩ
47 kΩ
0 V

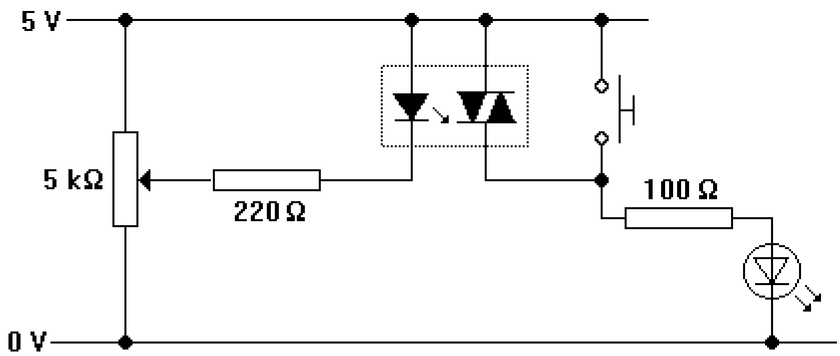

100 nF
4.7 MΩ
0 V


+5 V
10 kΩ
1 kΩ
0 V


100 nF
100 kΩ
0 V

Investigating an optotriac

1 Assemble the circuit shown below.



2 Connect a voltmeter between the wiper of the 5 k potentiometer and the 0 V supply rail.

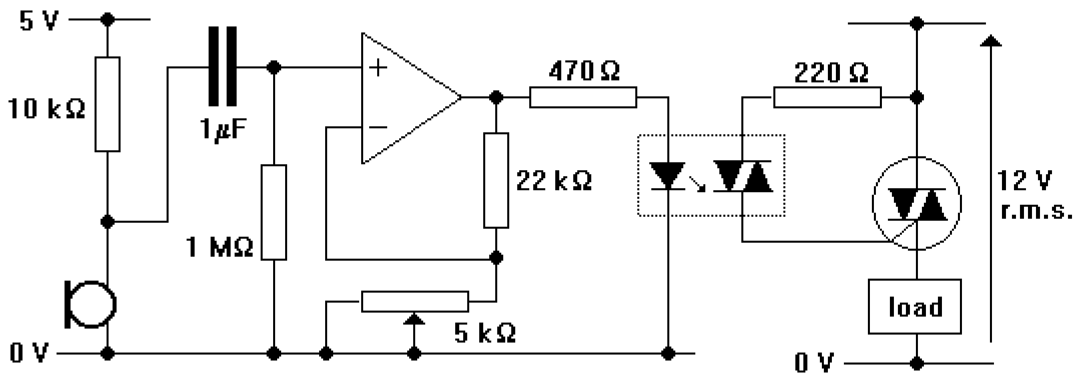
3 Set the wiper to +5.0 V and then press the switch. If all is well, the LED should be off.

4 Lower the voltage at the wiper until the LED comes on. Measure the voltage at either end of the 220 resistor at this point. Hence calculate the minimum gate current required to trigger the optotriac.

5 Return the wiper to +5 V. Press the switch briefly. Why does the LED go off and stay off?

A sound-to-light converter

You are going to assemble a circuit which uses the signal from a microphone to control a 12 V lamp. The circuit is shown below.



1 Assemble the part of the circuit which has the triac, load (a 12 V lamp) and optotriac. The 470 resistor needs to be in series with the LED of the optotriac. Note that the lamp is run from an a.c. supply.

2 Connect one terminal of the 12 V a.c. supply to 0 V. If all is well, the lamp should only glow when the free end of the 470 resistor is held at +5 V.

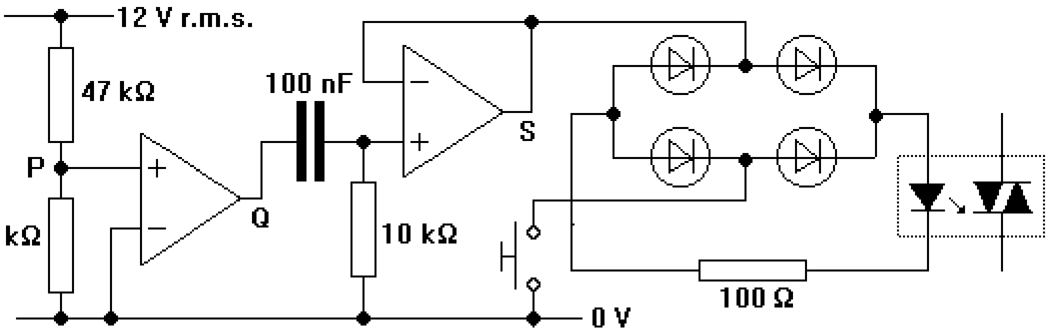
3 Assemble the rest of the circuit.

4 Use an oscilloscope (set to 1 V/div) to look at the output of the op-amp. If all is well, you should see an a.c. signal when you speak into the microphone. The potentiometer sets the voltage gain of the system.

5 Use the oscilloscope to look at the voltage across the load. Can you explain what you see when you speak into the microphone?

Zero-crossing pulses

The diagram shows a circuit which generates zero-crossing pulses for an optotriac. You are going to assemble it and investigate how it works.



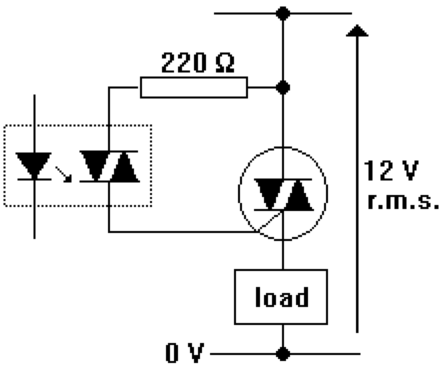
1 Connect one terminal of the 12 V a.c. supply to 0 V.

2 Assemble the voltage divider and the op-amp comparator (run off the usual supply rails of +5 V, 0 V and -5 V).

3 Use an oscilloscope to look at the signal at Q. It should be a square wave with a period of 20 ms.

4 Now assemble the spike generator and the op-amp follower. Look at S with an oscilloscope. Can you explain what you see?

5 Connect the op-amp follower to the optotriac LED via a diode bridge (using signal diodes), a switch and a 100 current-limiting resistor. Use the optotriac to operate a 12 V lamp, as shown below.



6 Check that the lamp lights up only when the switch is closed.

7 Use an oscilloscope to look at the voltage across the lamp. Is the lamp only switched on for whole half-cycles of the 12 V a.c. supply?