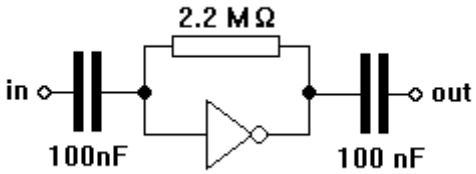
The effects of negative feedback

1 Assemble the circuit shown below, using one NOT gate from a 4069 i.c. Run it off supply rails of +5 V and -5 V instead of the usual +5 V and 0 V.

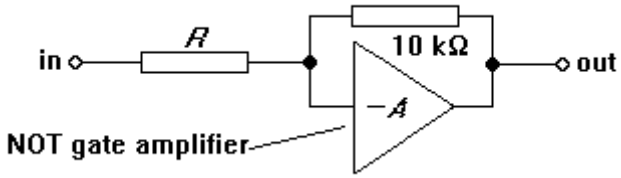


2 Use a signal generator to inject a 1 kHz test signal at the input. Use a double-beam oscilloscope to monitor the signals at the input and output. If all is well, the output should be at least ten times bigger than the input.

3 Explore the effect of increasing and decreasing the amplitude of the input signal. Admire the distortion of the output signal for large amplitude input signals.

4 Adjust the amplitude of the input signal until the output has a peak value of 1.0 V. Measure the amplitude of the input signal. Hence determine a value for the open-loop gain *A* of the amplifier.

5 Now use a couple of 10 k resistors to provide negative feedback, as shown below. The block marked NOT gate amplifier is the entire circuit shown above.



6 Check that the closed-loop gain *G* is now -1, with very little distortion (even at large amplitudes).

7 Use the following values of *R* in turn: 4.7 k , 2.2 k , 1.0 k , 470 and 220 . Measure the value of the closed-loop gain *G* each time, making sure that the output is not saturated.

8 Detailed theoretical analysis of the circuit suggests that $G = -1 \ 10^4/R$ when *G* is much less than *A*. Is this supported by your results?