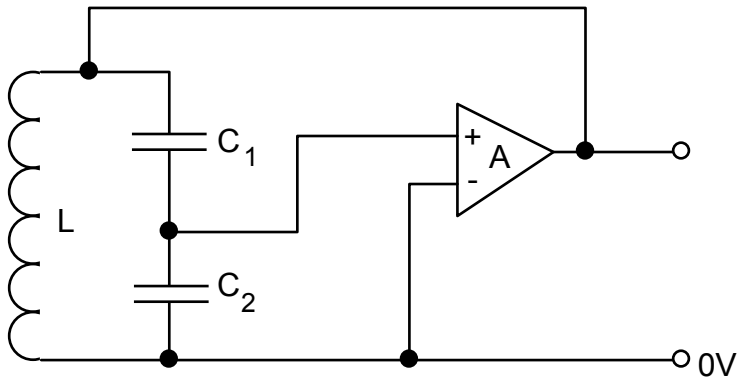
Colpitts Oscillator

The standard oscillator circuit is shown below.



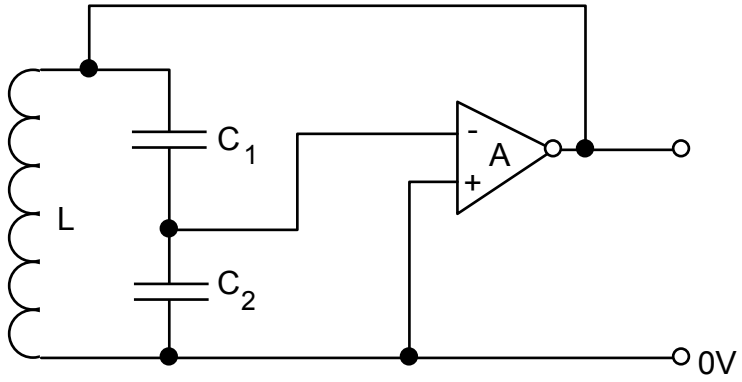
$$f = \frac{1}{2\pi\sqrt{\frac{L C_1 C_2}{C_1 + C_2}}}$$

C_1 and C_2 form a potential divider and it can be shown that for stable oscillation

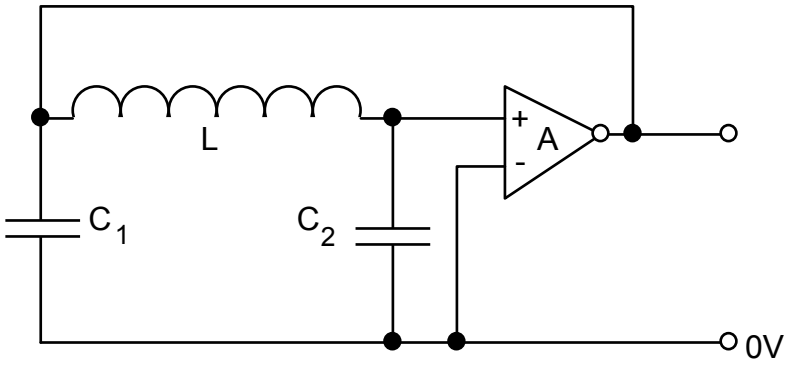
$$A \geq \left(1 + \frac{C_2}{C_1}\right)$$

The circuit can also be morphed by the following:-

1). Using an inverting amplifier - note the negation circle on the amplifier output.



2). Relocating the 0V line.



The amplifier can be a NOT gate and a suitable one is the 74HC04 IC which contains 6 NOT gates.

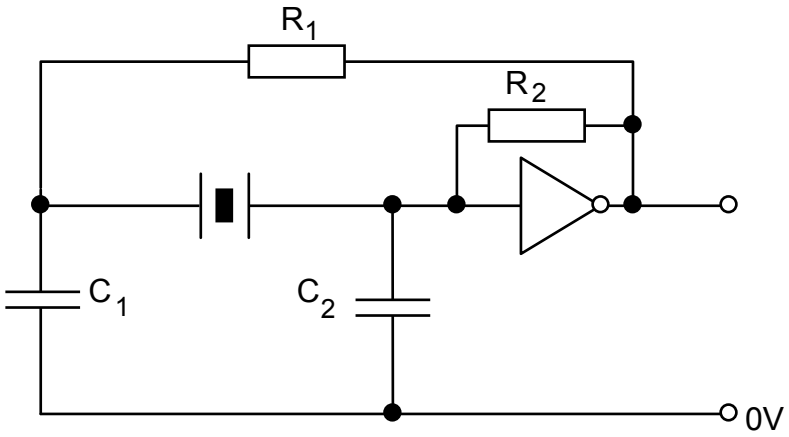
74HC04 details.

Supply voltage	2 - 6V
Propagation delay	14ns max
Output current	4mA
Maximum clock frequency	55MHz
Input capacitance	2.5pF typically

(reference Philips HC/HCT User guide 1997)

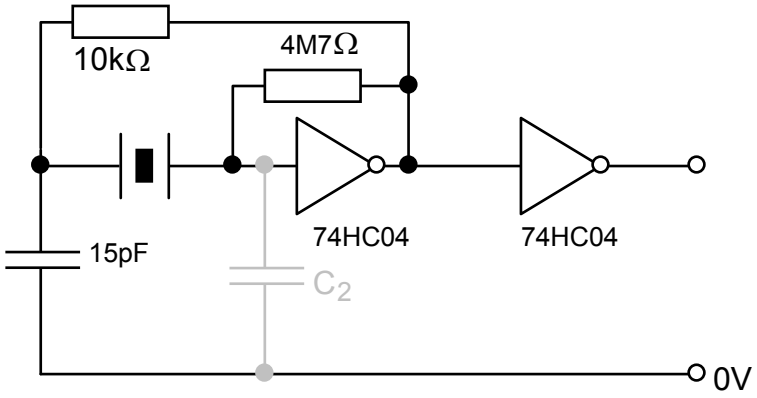
Crystal Oscillator

A crystal oscillator can be readily constructed using this circuit and a NOT gate.



Crystals do not conduct, and so the NOT gate needs to be biased using a resistor, R_2.
Many crystals will oscillate readily and so do not need a great deal of feedback to keep them in stable operation. A resistor, R_1, is therefore included in the feedback loop to the input of the crystal. The actual value of this resistor will need to be adjusted-on-test - the value chosen should be the largest value for which the crystal readily starts oscillating when power is applied.

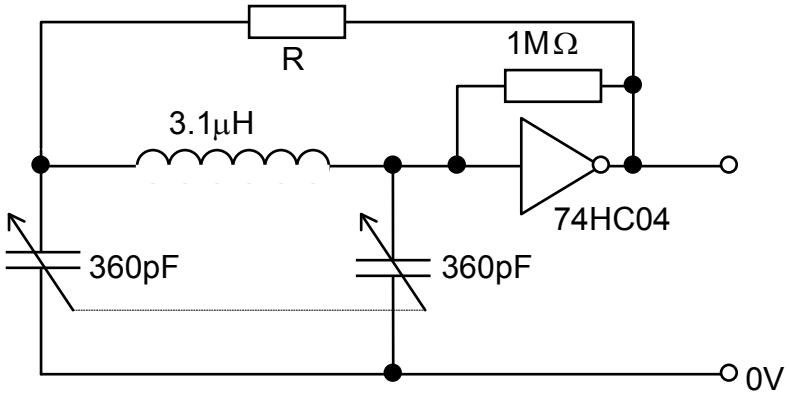
The circuit below works reliably with salvaged 3.579545MHz and 1.8432MHz crystals.



The capacitor C_2 has been omitted, the input capacitance of the NOT gate providing sufficient capacitance for reliable oscillation. C_1 can be a trimmer capacitor to allow the crystal frequency to be adjusted to a required value (± around 1kHz).
The 74HC04 operates from a +5V supply and a 100nF ceramic capacitor is used to decouple the supply at pin 14. The other gates in the 74HC04 IC are used to buffer the output of the oscillator.

Variable Frequency Oscillator.

A variable frequency oscillator can be readily constructed from the basic oscillator circuit using 74HC04 NOT gates. The circuit below has proved to oscillate reliably up to 34MHz.
With the values below a frequency range of 5.7 - 18.3MHz was achieved.

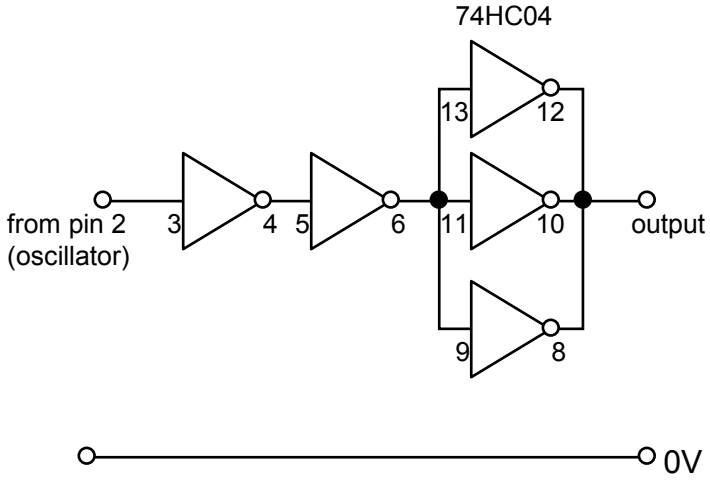


The coil was air wound on an old BIC biro tube.
The variable capacitor was air spaced and liberated from an old radio.
The 1MΩ feedback resistor is not strictly necessary as the coil will provide feedback from the output to the input of the NOT gate. However, since the circuit has been used for various investigations with inductors, the resistor was included to prevent any static damaging the input to the NOT gate.
The resistor, R, is included to limit the drive to the tuned circuit, and will need to be adjusted on test to provide reliable oscillation, a stable frequency and clean waveform, as in the crystal oscillator version.. Values of R range from 0 to around 10kΩ for most tuned circuits.

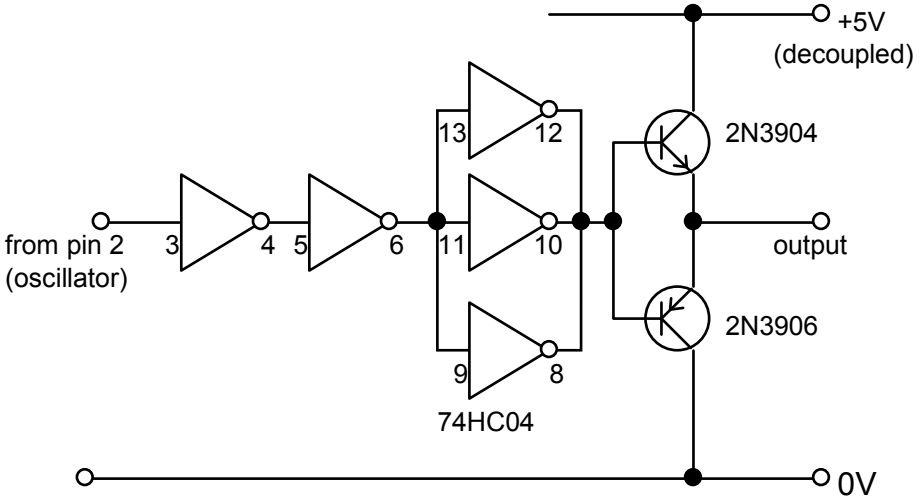
The 74HC04 operates from a +5V supply and a 100nF ceramic capacitor is used to decouple the supply at pin 14. The other gates in the 74HC04 IC are used to buffer the output of the oscillator.

Buffer circuit.

The 74HC04 IC contains six NOT gates. With oscillator circuits it is essential to buffer the output of the oscillator to prevent external circuits from disturbing the oscillating frequency.
For all of the oscillators discussed, the gate between pins 1 and 2 is used for the oscillator circuit, and the other gates are used for the buffer as shown below.
The 74HC04 operates from a +5V supply and a 100nF ceramic capacitor is used to decouple the supply at pin 14.



The NOT gates connected in parallel enable the buffer circuit to provide an output current of around 10mA. This can further be increased by adding a pnp and npn transistor pair as shown below.



The +5V supply is decoupled with a 100nF ceramic capacitor and a 10µF capacitor.
This circuit has a frequency response beyond 20MHz (the limit of tests so far) and will supply an output current of around 50mA.
A disadvantage of this transistor addition is that the output voltage now only swings between +0.6V and 4.4V, i.e. it no longer provides a 0 - 5V output. However, this does not seem to be a problem when driving other logic gates operating from a +5V supply.