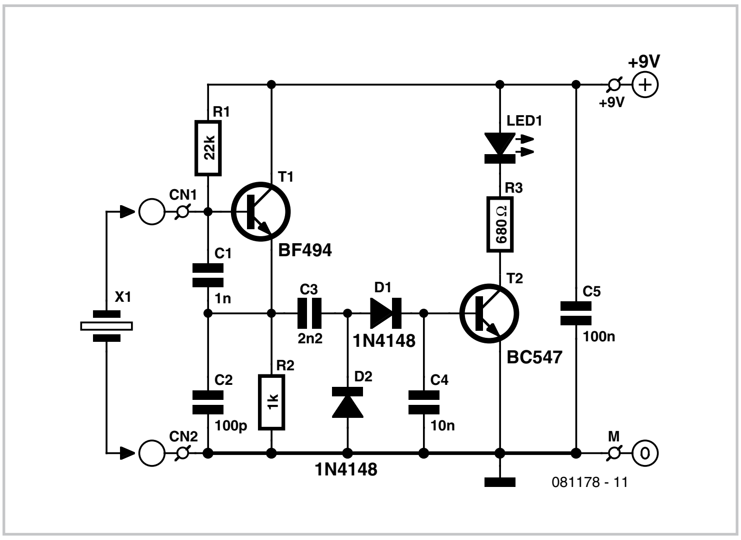
Quartz Crystal Tester

Christian Tavernier (France)

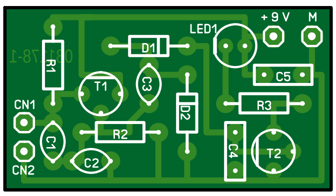
Although most passive components are usually fairly easy to test, the proper functioning of a quartz crystal cannot be checked using any standard measuring instrument. A quartz crystal is actually a very simple device in principle, since all it consists of is a slice of quartz, accurately cut, of course, held between two metal electrodes, or with metallic contacts deposited on it to serve the same purpose. But sadly, owing to its being made like this, an ohmmeter or capacitance meter will not measure anything across a crystal, since it will have a resistance of several megohms (MΩ) and a stray capacitance of only a few picofarads (pF) — regardless of whether it's working or not. So the only solution available to us is to fit the crystal into a circuit, i.e. an oscillator, and see if it oscillates or not. This is just what our tester does — and at a ridiculously low cost.



As the frequencies of the crystals we deal with may cover a very wide range — the vast majority of them will be typically between 1 MHz and 50 MHz — we need to build an oscillator that will be capable of working over a very wide frequency range. This task is given to transistor T1, which is arranged as an aperiodic oscillator — i.e. it is not tuned to any particular frequency. If you are familiar with this type of oscillator circuit, you'll note that the feedback capacitor C1 has an unusually high value, which enables this circuit to cope with almost any type of crystal with a frequency between 1 and 50 MHz.

So if the crystal is good enough, a pseudo-sinewave signal at the crystal's fundamental frequency will be present at the emitter of T1. This signal is rectified by D2 and charges capacitor C4 via D1. As soon as the voltage across this reaches a high enough value, transistor T2 turns on and lights the LED in its collector circuit, thereby indicating that the crystal is usable.

Clearly, because of its operating principle, this circuit doesn't let us check the actual operating frequency of the crystal, but experience shows that, when a crystal is faulty, it will fail to oscillate at all, but that when it does oscillate, it will do so at the frequency for which it was made, or one of its harmonics (see below). If it's important for you to measure this frequency, you can connect a frequency meter or oscilloscope across resistor R2.



The circuit itself is very simply and can be built on the little dedicated PCB whose design we have suggested for you [1], or on a piece of prototyping board (perfboard, Veroboard etc.). In either case, it is essential for the base material to be fibreglass and not paxolin, because of the high frequencies that may be involved.

To achieve the connection to the crystal to be tested, two HC6/U and HC18/U sockets can be soldered in parallel to accommodate crystals using these pin-out formats. Crystals that have wire leadouts can easily be connected to one or other of these two sockets.

The power supply is provided by a source of 9 V. A simple 9 V PP3 battery is ideal, given the circuit's low power consumption and above all the fact that it's only ever used for a relatively short time.

As previously explained, the circuit works for any crystal with a frequency between 1 and 50 MHz — i.e. virtually all the crystals on the market. It's important to appreciate that, even though you do find crystals marked with frequencies higher than 50 MHz, they rarely actually operate directly at this frequency, which is in fact the harmonic frequency to which the oscillator in which they are fitted needs to be tuned. So their fundamental oscillating frequency is in fact normally below 50 MHz, by a ratio of 2 or 3, depending on which harmonic (or overtone) is to be used. The reason for this curious way of going about things lies in the manufacturing technology for these devices, which requires the slice of quartz to be finer and finer as the actual operating frequency (or 'fundamental frequency') is increased. And so, if they try and go too high with direct oscillation at the fundamental frequency, the slice becomes so fragile that it may break all of its own accord.

(081178-I)

COMPONENT LIST

Resistors
R1 = 22kΩ
R2 = 1 Ω
R3 = 880Ω

Capacitors
C1 = 1nF
C2 = 100pF
C3 = 2nF2
C4 = 10nF
C5 = 100nF

Semiconductors
D1, D2 = 1N4148
T1 = BF494
T2 = BC547
LED1 = LED

Miscellaneous
Socket for HC6/U and/or HC 18/U type xtal

Internet Link

[1] www.elektor.com/081178

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PCB

081178-1: PCB layout (.pdf), from [1]