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TRANSISTOR AND CRYSTAL TESTERS YOU CAN BUILD

How many times have you wondered if a transistor or crystal you had on hand was defective? The worst time to start worrying is when it's already part of a circuit you're building.

You can avoid that sort of headache by building one of these simple, inexpensive testers. It'll only take a couple of hours and they'll give you years of use if you're the sort of person who likes to experiment or repair your own radios.

A Simple Crystal Tester

A battery-operated crystal test set can be used for a number of applications. Take for example those jaunts through a radio flea market. You chance upon a table that has a box of crystals at a bargain price per unit. Are these crystals OK? As they say, "Let the buyer beware." How convenient it would be if you had a portable crystal tester for checking the crystals you wish to purchase. The circuit in Fig. 1 makes this possible.

Now, let's imagine that we are in our workshop and we want to measure the operating frequencies of some crystals we have purchased. It is a simple matter to pop the crystals into our tester and connect a frequency counter to the test point specified in Fig. 1. Sometimes it's necessary to select two or more crystals that are very close in frequency; e.g., when building homemade IF (intermediate frequency) filters. The test oscillator and frequency counter make this possible. A well calibrated communications receiver may be used in lieu of a frequency counter if you listen to the oscillator signal.

How about other uses for your crystal tester? There are many times when an experimenter needs a signal generator for aligning a receiver. You can insert a crystal of the appropriate frequency in the little tester and proceed with the peaking of your receiver trimmers or adjustable coils. If you are thinking about becoming a ham, you can use the oscillator for code practice by inserting a key jack in the emitter or source lead of the oscillator (depending upon which tester you build). The oscillator signal can be monitored with a receiver when you practice sending the Morse code.

Crystal-Tester Circuit

Fig. 1 shows the circuit for our tester. The diagram at A is for a JFET (junction field-effect transistor) oscillator. Circuit B shows how to use a BPT (bipolar transistor). Both circuits operate as Pierce oscillators. There is no tuned circuit. Therefore any fundamental crystal for, say, 1 to 20 MHz can be checked. Overtone crystals (3rd or 5th) can also be checked. They will oscillate at their fundamental frequencies rather than at the overtone frequency. For example, a 30-MHz 3rd-overtone crystal or "mode" will oscillate at approximately 10 MHz in the tester. The third overtone of a crystal is seldom an exact multiple of the funda-

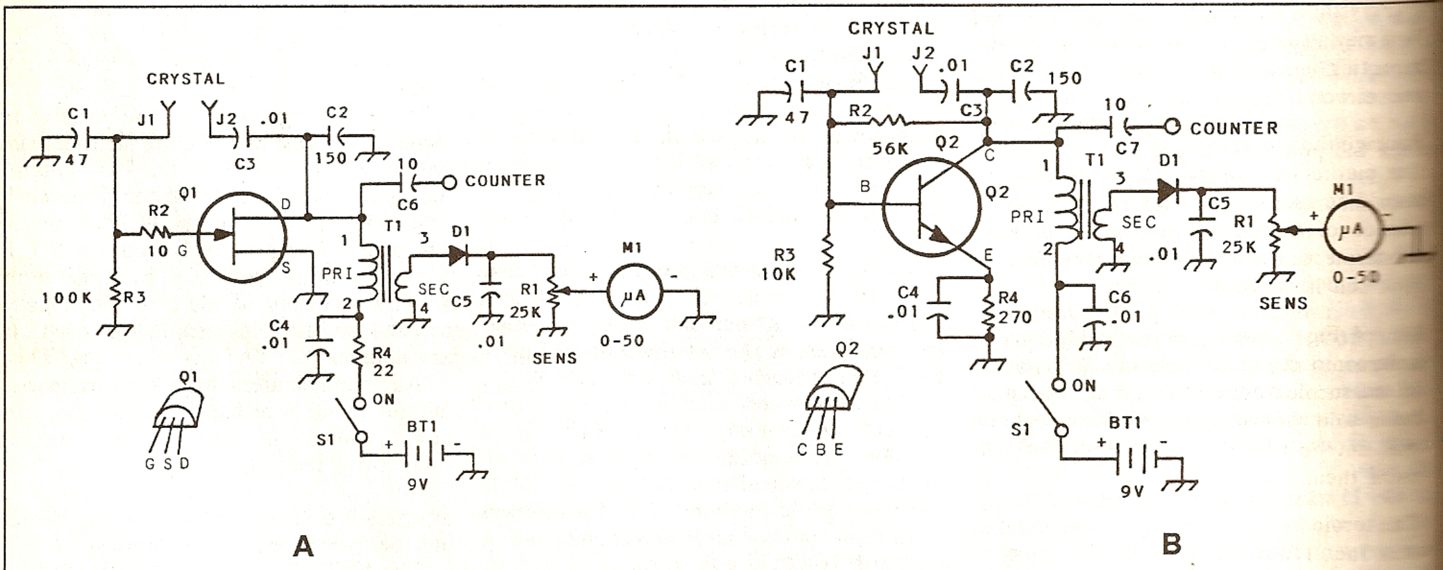

Fig 1 - Schematic diagrams of two crystal testers.

Circuit A uses a JFET and circuit B features a bipolar transistor. Decimal value capacitors are in µF. Others are in pF. Resistors are 1/4 watt carbon composition. All capacitors are disc ceramic. D1 is an 1N34A germanium diode. A 1N914 may be used also. J1 and J2 are binding posts, a crystal socket or two alligator clips mounted near Q1 or Q2. M1 is a 50 or 100 µA dc meter (see text). Q1 is an MPF102 or 2N4416. Q2 is a 2N3904, 2N2222 or 2N4400. R1 is a panel mount carbon control. An spst toggle or slide switch may be used for S1. T1 has 20 primary turns of no. 26 enamel wire on an Amidon FT-50-61 ferrite toroid (see text). The secondary has five turns of no. 26 wire. BT1 is a transistor radio battery. A 12-V dc supply may be used without circuit changes.

mental frequency, so don't be alarmed if your mathematics appear incorrect!

C1 and C2 of Fig. 1 provide the feedback that makes the crystal oscillate (vibrate). remember that crystals, when oscillating, vibrate. For example, a 1-MHz crystal goes through 1 million cycles or Hertz per second! You may experiment with the C1, C2 values if for some reason your oscillator doesn't work.

Broadband transformer T1 in Fig. 1 has a primary winding that acts like an RF choke. The secondary (smaller) winding provides a low-impedance take-off point for the output signal. Energy from the secondary winding is rectified by D1 to produce a dc voltage. This voltage causes the meter, M1, to deflect when oscillation takes place, thereby indicating crystal action. Sensitivity control R1 permits you to set the meter needle at midscale. A quality crystal (good activity) will deflect the needle quite high, whereas a sluggish crystal will provide a low reading. Surplus crystals in FT-243 holders may be more sluggish than are the plated crystals in metal holders.

Two circuits are illustrated in Fig. 1. You may use either one. The JFET oscillator has fewer parts, but performance will be about the same for both circuits. Any high-frequency or VHF JFET is suitable for circuit A. You may use an MPF102, 2N4416 or equivalent FET. You may also use a dual-gate MOSFET (40673, 3N211, etc.) at Q1 of Fig. 1A by tying the two gates together and using the device as a JFET. Circuit B may use any bipolar transistor that is specified for use up to the UHF range. Devices like the 2N3904, 2N2222 and 2N4400 are good choices.

Practical Considerations

Our crystal tester can be assembled on a perf board or a PC board. You may also use terminal strips as tie points by soldering the strip mounting lug to a piece of blank PC board. Keep all leads short and direct.

Package the circuit in a small project box if you plan to carry it to flea markets for crystal testing on the spot. A larger enclosure should be fine for your workshop model. Keep in mind that your version of the Fig. 1 circuit need not look like an engineer's masterpiece. It will serve you well, no matter how ugly it looks -- provided it is wired correctly!

M1 of Fig. 1 will yield the best sensitivity if it is a 50 uA (microampere) meter. A 100 uA meter will be suitable also. Most of the surplus edgewise FM tuning and S-meter units that are being sold today are 200 uA types. They can also be used, but it may not be possible to obtain full-scale meter deflection when using them with this circuit.

The toroid core for T1 is available by mail from Amidon Associates, Inc., 12033 Otsego St., North Hollywood, CA 91607 (catalog available). Do not substitute a toroid core of unknown characteristics. The wrong core can prevent the circuit from working. The FT-50-61 core specified is ferrite, 0.5 inch OD and has a permeability of 125, should you want to substitute another brand. Many of the parts for this circuit are available by mail from Oak Hills Research, P.O.B. 250, Luther, MI 49656. Send and SASE to receive a catalog.

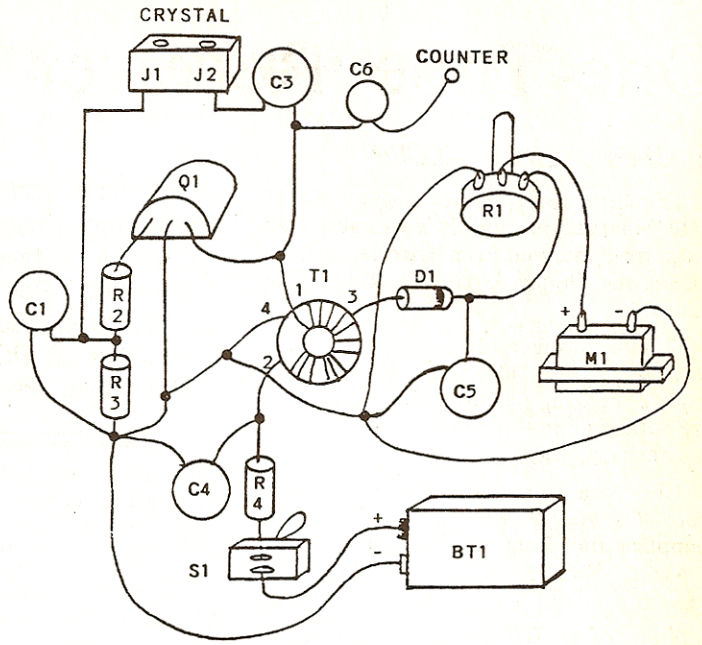

Fig. 2 -- Pictorial diagram of the circuit in Fig. 1A. This shows how the parts are connected together. Keep in mind that the component leads (except for the dc leads) must be kept much shorter than they are depicted here.

Using the Tester as a Transistor Checker

If you want to test small-signal bipolar transistors with the circuit in Fig. 1, you may install a transistor socket at Q1. The TUT (transistor under test) is plugged into the socket for evaluation. If the M1 meter deflects, the transistor is good. You will need to have a crystal plugged into the tester when checking transistors. I suggest that you use an 18 or 20 MHz crystal for this operation. Many low cost surplus crystals are available in this range. As shown, the circuit will check only NPN types of transistors. If you wish to test PNP transistors, merely reverse the polarity of BT1. A reversing switch (DPDT toggle) may be installed at BT1 for this purpose.

You can evaluate the relative gain of TUT's when grading out like-number devices. Observe the deflection at M1 (R1 left in a given position) while plugging various transistors into the tester. The greater the transistor gain the higher the meter reading. This is useful for matching transistor pairs for critical circuits, such as mixers and balanced modulators.

Tag Ends

I feel that this project is within the capability of anyone who can read a circuit or pictorial diagram. Don't be afraid! It's fun and educational.

There is no reason why the shortwave listener shouldn't gain technical knowledge to complement his or her tireless bandscanning! The pride you will experience from constructing a useful gadget cannot be measured in hours or dollars. I hope you'll give this handy tester a try!

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