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FIGURE 1

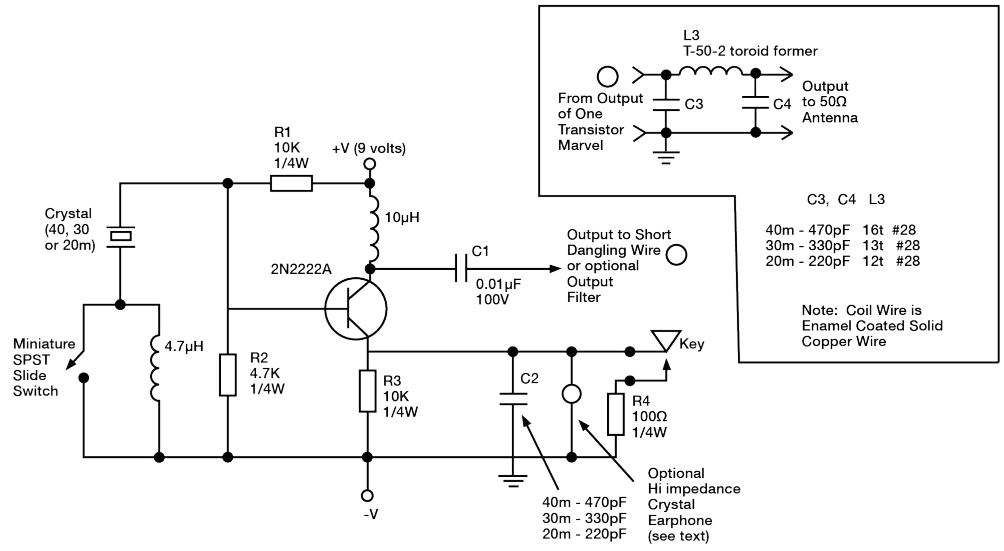

Figure 1: Circuit diagram of the One Transistor Marvel with inset showing values of optional band filters. Deta in text.

The One Transistor Marvel

One transistor and eleven other parts can form a complete QRP transceiver, as Dave Ingram explains.

QUICK AND EASY. One of the most popular quick-assembled projects among U.S. amateurs in general – and QRPers in particular – is the one transistor transmitter. It is inexpensive, easy to build, and using it on-the-air for occasional QSOs always proves that it's the operator, rather than the rig, that makes the big difference in communications abilities. In light of those facts and considering the benefits of "pocketable" HF communications, I devised the multi function mini rig shown in Photos 1, 2 and 3. Look closely at the circuit: it is quite unique.

Essentially, this item is a combination QRP transmitter, wireless BFO/receive converter, personal emergency beacon and low gain HF micro transceiver in a tiny package. The unit can be built for operation on 80, 40, 30 or 20 meters, powered by a regular 9V battery, and the output is approximately 70mW of genuine DX-grabbing power. A 9V battery is utilised because it minimizes stress on the transistor and allows any length of wire to serve as an antenna without concern over high SWR. The antenna can even be omitted for close-in-work. Typical range with a short (one or two foot) dangling wire/antenna is approximately 700 feet (~200m), which is ideal for home experiments, keeping in touch with the HF mobile rig during travel stops, and for monitoring/joining QRP activities at conventions or rallies. Alternately, the mini-rig can be connected to an optional output filter and a full-size outdoor antenna like a dipole for serious QRP work. I might also add that this little gem has only 12 components. If you like simple, fun projects you can build in one or two hours, this mini rig is a winner!

SIMPLE CIRCUITS, SIMPLE MODS. Generally speaking, circuit designs for one-transistor transmitters fall in the Colpitts, Pierce or basic crystal oscillator category. The latter circuit, a regular crystal oscillator, is first choice here as a VXO circuit can be included in series with the crystal without disrupting feedback for operation. Resistance in the transistor's emitter leg can also be changed to vary output power without adversely affecting oscillation. Some one-transistor transmitters may exhibit instability or chirp, but close study shows such entanglements typically result from direct-keying a "pushed to the limit" oscillator. Through precise selection of components and operating parameters, however, we can emerge with a simple circuit **(Figure 1)** capable of surprisingly good performance.

First, a small (resistor size) moulded inductor is used to save space and shift the crystal's frequency. A low value inductance is also utilized to hold the shift within two or three kilohertz and ensure good frequency stability. Using a moulded inductor has another benefit here: it eliminates tedious coil winding. Shifting frequency is also easy: just short out the inductor with a tiny slide switch.

Next, notice the two resistors (R3 R4) included in the transistor's emitter circuit. The high value resistor (R3) causes

mini-transmitter to produce a continuous 100 or 200-microwatt signal during key up. This signal is too weak for other stations to hear, but it easily radiates as a wireless BFO signal to a nearby AM-mode shortwave receiver. Closing the key shunts R3 with a low value resistor (R4), which causes the output to increase to approximately 70mW for transmitting. Since the circuit is already oscillating, it just steps up the power, rather than "starting from zero" at key down. This significantly reduces chirp. The change from microwatts to milliwatts also produces an approximate 400Hz frequency offset for copying CW (don't confuse this with chirp!).

I decided to use the ever-popular 2N2222A transistor: a "small signal device" rated at 500mW so it runs cool, comfortable and stable at 70mW. I prefer the plastic cased version (a PN2222A), as it operates reliably right down to 1.5V for emergency use with a tiny AAA or N cell. Maplin Electronics is one of the many sources of the 2N2222A, and you can often pick them up at rallies or even salvage them from old boards.

I should also point out my previously discussed mods can be integrated into other simple/single transistor (or valve-type) circuits. Feel free to experiment and if you use my expansions in a project/circuit, I only request you refer to it as the "Ingram Mod". Fair enough?

RESULTS AND APPLICATIONS. Now we've explained the "why and how" of our one transistor marvel, let's explore its four main applications (QRP transmitter, wireless BFO, personal beacon and micro transceiver). When connected to an appropriate band filter (Figure 1) and outdoor antenna, amateurs in the U.S. have communicated from coast to coast with this 70mW transmitter. Really! It is amazing! The value of R4 can be reduced slightly to increase output, if desired, but the transistor may overheat and croak if resistance is less than 60Ω. Remember the transistor is only rated at 500mW.

As previously mentioned, this unit's continuously generated low level signal serves admirably as a wireless BFO for copying CW on an inexpensive AM shortwave receiver. Just place it near the receiver, experiment with the distance to obtain the best injection level, and its signal will beat with incoming signals to produce a CW note. All incoming signals within the receiver's (AM) passband can be heard so you just concentrate on one tone and ignore the others. This hands-free monitoring technique works well at home, in the field or in a hotel and must be experienced to be fully appreciated. It is terrific! Low cost shortwave receivers typically exhibit high RF gain and limited AGC action. They are extra-sensitive and work quite well for receiving CW stations with only their pull-up/whip antenna. If

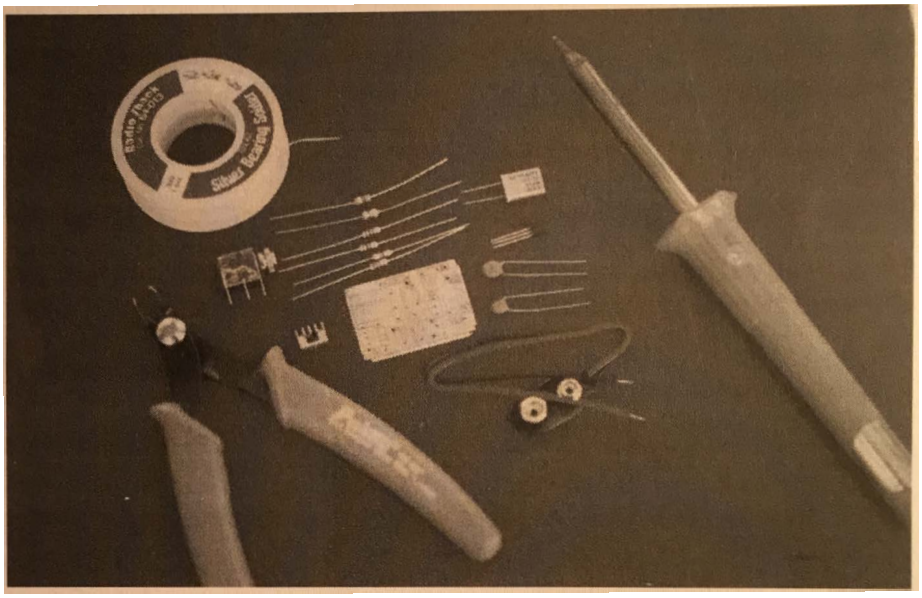

Photo 1: Our featured mini-project laid out and ready for assembly. This little gem consists of only 12 parts yet it is a combination QRP transmitter, wireless BFO/receive converter, personal emergency beacon and low gain micro transceiver on a 1 x 1.5 inch (25 x 38 mm) PC board. It is an ideal "first project" for new homebrewers.

Photo 2 The completed four function mini project mounted in a tiny keyfob pillbox for 'go anywhere HFing" Just add a 9V battery, miniature Morse key and dangling wire antenna and you have the ideal travel mate

receiver overload is a problem when transmitting, try shorting the pull-up antenna to ground or to the earphone socket's outside terminal during key down time. If your receiver includes a BFO, incidentally, just disconnect one end of R3. Leave it connected at the other end so you can quick-reconnect it if/when needed later.

Finally, this mini-rig can serve as a micro-transceiver by connecting a very high impedance (crystal) earphone across the key or in parallel with R3, the 10k emitter resistor. No RF or AF amplification is included here, so performance is generally comparable to or on par with a BFO-equipped crystal set. As a typical reference, it can receive a five-watt signal over a distance of approximately 700 feet. Limited range? Nay, nay. It is ideal for "keep in touch" security with your HF mobile rig during travel stops. It is also perfect for monitoring (and joining!) QRP activity around hotels during conventions and rallies. As you probably know, QRPers like to meet in quaint areas/rooms and play with small rigs at rallies. Joining such activity is also easy with this mini-rig: just grab the key and transmit. A short wire is all you need as an antenna for around-hotel communications.

PACKAGING MAKES THE DIFFERENCE. The small size and simplicity of quick-assemble projects make them ideal candidates for fitting into palm-size enclosures like pillboxes or mint tins. Since the majority of this mini project's life probably will be serving as a wireless BFO for a low cost and portable shortwave receiver, there is merit in installing it in a plastic case so it can radiate freely without a dangling wire antenna. A tiny keychain-type pillbox is first choice here. An attractive alternative is a Tic Tac mint box. Just remove its sealing paper and cap, install the One Transistor Marvel and you have a neat box with flip top access to the frequency switch or key socket. Now that is truly "take it with you HFing"!

KITS AVAILABLE. We understand many readers would like to quick-assemble a "One Transistor Marvel" like featured here but lack time or patience to hunt down parts and etch a PC board. I have therefore put together some kits to support your endeavours. The kits are supplied with a predrilled and well-marked 1 x 1.5 inch PC board, a crystal for 3.580, 7.040, 10.106 or 14.060MHz (your choice) and other components. The kit does not include the optional output filter. The basic kit is US $16 plus $4.00 postage air mail to the UK ($20.00 total). I also have a small supply of crystal earphones and key fob cases – but they are disappearing rapidly. Check with me at k4twj@cq-amateur-radio.com for availability and acceptable methods of payment.

CONCLUSION. Nothing beats the personal gratification and enjoyment of experimenting with simple circuits and small transmitters, and we urge you to join the fun. Indeed, the knowledge you can devise a working transmitter and mating/integral receive converter for impromptu communications anytime and anywhere needed is priceless. Give it a go, and may the force of good signals always be with you!

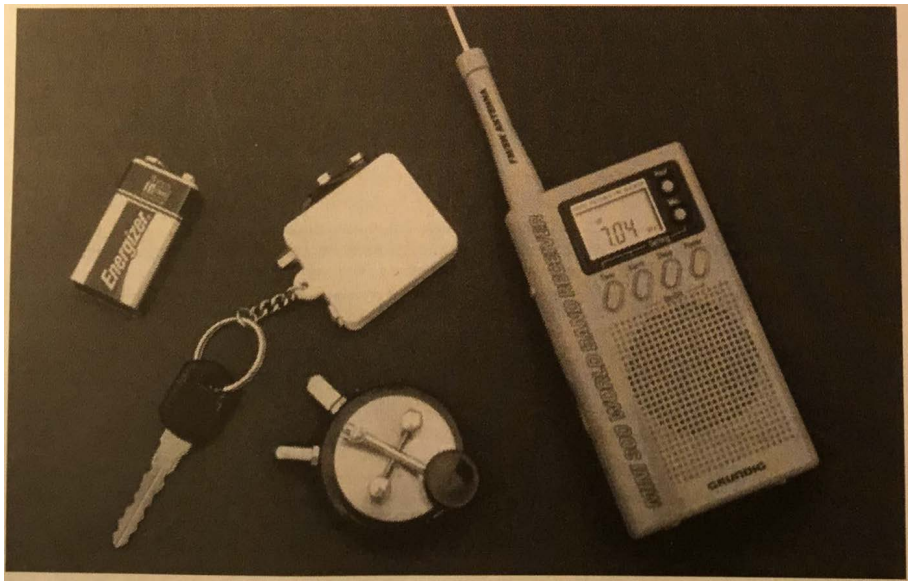

Photo 3 When placed beside a low cost AM type shortwave receiver, the mini project serves as a wireless BFO for receiving CW signals. Two adjacent frequencies are switch selectable without retuning receiver and transmitting back to stations simply involves tapping Morse code with the key. A slight CW offset is also included. Details in text.

NOTES FOR NEWCOMERS

Don't feel intimidated if you're new to home construction. The Homebrew column has covered most of the techniques necessary to build this little circuit, which can easily be made on veroboard or even 'dead bug' style. And anyway, you probably know at least one "old-pro" amateur and if asked respectfully, he would probably be honoured to guide you. Just use a small "pencil-type" 30 or 35-watt soldering iron with a very fine tip and ultra thin solder (22SWG is ideal, but 18SWG will work fine). Before heating the iron, check to ensure its tip, the solder and wires to be soldered are all in the same size category (if the iron or solder is too large, it can "bridge" adjacent connections on a veroboard or a PCB). Next, practice with some extra or "junk box" parts and wires to perfect your technique before progressing to the actual circuit. Remember to heat connection points hot enough to melt solder (which will then flow onto connections) rather than applying solder to the iron until it heats enough to roll onto cool junctions.

Mount components close to their circuit board for good workmanship and stability. Solder one lead of each component "round robin style", then go back and solder the second lead of each component. When ready to check out the completed project, snap on one of the 9V battery posts and turn the battery clip 90 degrees. Insert your trusty multimeter (set to read milliamps) in series/between the open clip terminal and battery post. The meter should read 0 4mA to 1.0mA (0.0004 to 0.001 amp) with the key up and 30 to 35mA (0 030 to 0.035A) key down. If no current is indicated, look for an open circuit/loose connection in the battery, transistor and emitter wiring. If current is excessive (100mA or greater), look for a short circuit in the same area. Maintain patience (you are learning while doing) and success will be assured.