qrp

BY DAVE INGRAM,* K4TWJ

Quick-Brew Fun: The Super Mite

Our quest to help newer amateurs discover the unlimited fun and excitement of QRP continues this month with a special quick-brew project with widespread appeal: a mini-transmitter with some really unique features. As I have mentioned in previous columns, dinking with simple circuits and occasionally building one or two pieces of radio gear just for fun has always been one of QRP's top attractions. Indeed, nothing compares to the thrill and exhilaration of contacting other amateurs with a small rig built by your own hand. That, dear friends, is the sheer essence of amateur radio!

Our featured "Super Mite" is an ideal first project in this respect. It can be assembled for 40, 30, or 20 meters; its circuit is simple and well proven; and it includes some very special mods, such as *VXO frequency control and a wireless BFO mode for transceiver-type operation with a portable AM shortwave receiver.* I have even put together some low-cost

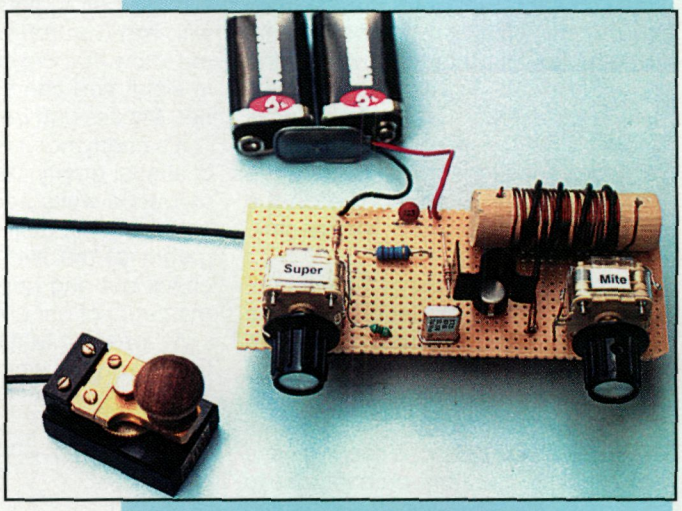

Photo A– Meet the Super Mite, a quick-brew, one-transistor transmitter for 40, 30, or 20 meters with VXO frequency control and "no connection required" BFO function for transceiver-type operation with an external AM/FM/shortwave radio. The little delight is powered from readily available 9-volt batteries and pumps out a clean 900-milliwatt signal.

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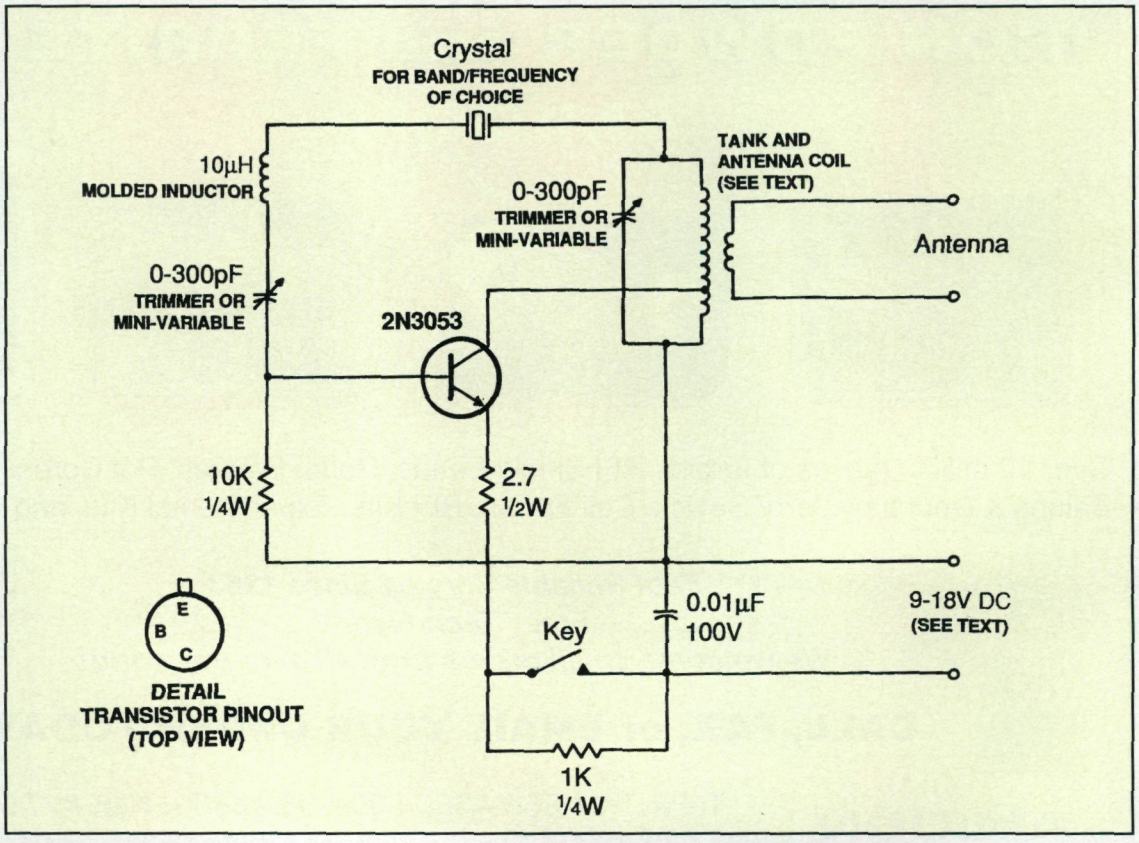

Fig. 1– Circuit diagram of the full-featured Super Mite transmitter. Value of emitter resistors can be juggled to fit your specific needs. (Discussion in text.)

1 1/4" Diameter Coil Form			5/8" Diameter Coil Form	
Band	Tank Coil	Antenna Coil	Tank Coil	Antenna Coil
40m	26 turns	4 turns	44 turns	4 turns
30m	16 turns	4 turns	25 turns	4 turns
20m	14 turns	4 turns	18 turns	4 turns
All coils tapped at 5 turns. All coils wound with No. 18 solid, insulated hook-up wire.			Tank coils tapped at 6 turns. Tank coils wound with No.22 enamel-coated copper wire. Antenna coil wound with No. 18 solid insulated hook-up wire.	

Fig. 2– Coil data for the Super Mite mini-transmitter.

parts packages of the Super Mite for your homebrewing convenience.Sound enticing? Read on.

Meet the Super Mite

A number of QRP friends asked me to devise or highlight a simple transmitter project they could whip together in three or four hours and use to make a few special contacts and show their colleagues. They wanted a battery-powered unit that could be assembled "breadboard style" on perfboard so they could plan their own layout, run their own wires, and modify them as desired. Our Super Mite meets those needs in high style, plus you can package the finished transmitter in several cool ways to fit your own preference.

If you look at the Super Mite's full circuit diagram in fig. 1 plus check out our quick-brewed version in photos A and B, you will notice the elegant simplicity of this little gem. A cylindrical coil, tapped to match the transistor's collector, is used in the tank circuit. It is tuned to resonance (minimum emitter current and maximum output power) with a small 300-pFd compression-type trimmer capacitor or plastic-case variable capacitor such as that used in a pocket AM radio. A second variable capacitor is paired with a 10-µHy inductor and used VXO style to shift the crystal's frequency between 5 and 15 kHz (the exact range depends on the crystal and band of operation).

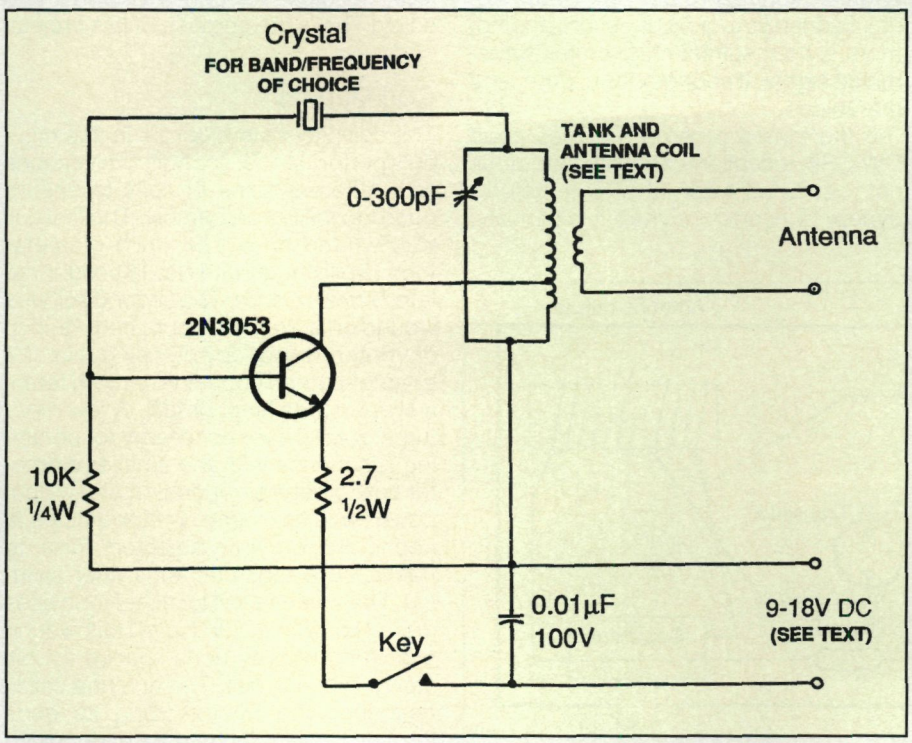

Fig. 3– Circuit diagram of the basic Super Mite. Assemble this "bare bones" circuit first, ensure it works smoothly, then add the special "frills" included in fig. 1, and your homebrewing success is eminent.

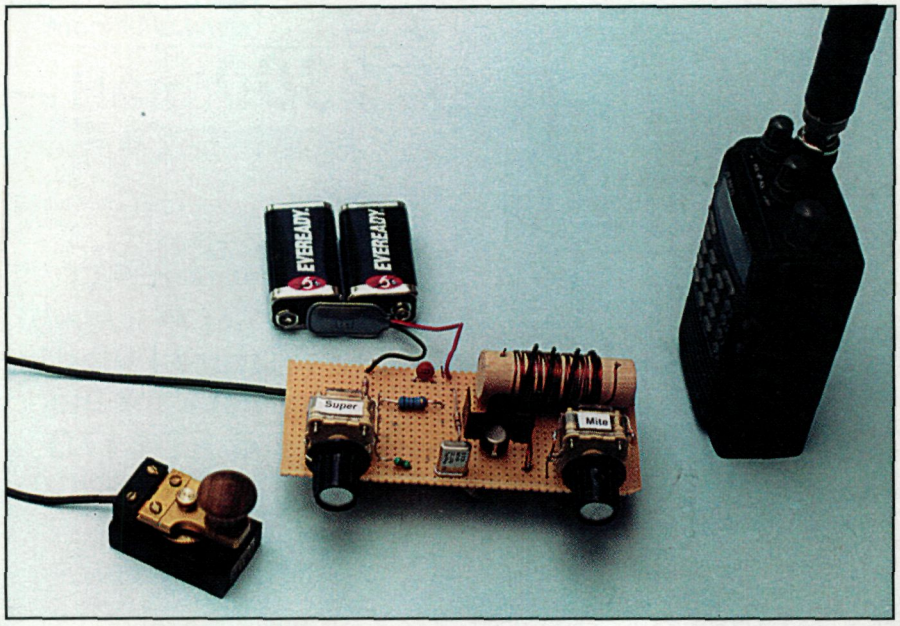

Photo B– The Super Mite's wireless BFO function works with almost any portable shortwave radio or VHF/UHF/HF receiver for on-the-spot survival communications and emergency preparedness, important considerations during these uncertain times. It is a neat, fun project for setting your own QRP records, too!

Two resistors are wired in series with the transistor's emitter. The 2.7-ohm resistor limits current flow during transmit/keydown to prevent transistor overheating. The 1K-ohm resistor allows the transmitter to function as a wireless BFO for its mated receiver during receive/keyup time. Say what? Notice the key connects in parallel with the 1K-ohm resistor. When the key is up, it limits its emitter current to less than 10 ma and output is only a couple of milliwatts—just strong enough to radiate to a nearby receiver and act like a BFO to beat or heterodyne with incoming signals. Closing the key shorts out the 1K-ohm resistor so emitter current increases to between 100 and 140 ma and output increases to maximum. As an extra benefit, the change of voltage between receive/keyup and transmit/keydown causes a very slight shift in frequency—a bare offset so you can copy another signal zero-beat with your signal. I sense your next question, and no, there is no resultant chirp on the transmitted signal. It sounds clean, pure, and marvelous.

If the mated receiver includes good CW/SSB reception capability and does not require an external BFO to heterodyne with incoming signals, incidentally, just remove or delete the 1K-ohm resistor. Be sure, however, to leave the emitter's 2.7-ohm resistor wired in series with the key. If you use the external BFO idea, only coarse frequency tuning (roughly within 5 or 6 kHz) will be required at the receiver. Fine frequency tuning of both the Super Mite and its mated receiver is handled "transceiver style" with the VXO capacitor. Wild, eh?

If a 9-volt battery is used for power and output coupling is light, power output will be around 400 milliwatts. Preferring a bit more power, I threw caution and transistor ratings to the wind and connected two readily available 9-volt batteries in series. Yes, indeed, a hearty 18 volts total and a rompin' 900 milliwatts of band-blasting power! Oh the pleasures of unrestrained dinkin! This measure is "pushing" the little 2N3053, however, so a few words of advice (caveats?) warrant mentioning. Use a big heat sink on the transistor and avoid holding the key down for extra long dashes. Touch a fingertip to the transistor within its heat sink. If it is hot, reduce the voltage or increase the 2.7-ohm emitter resistor's value to 10 or 15 ohms. If higher power is still your goal, try substituting a more heavy-duty (and more expensive) RF transistor such as a 2N3553, 2SC799, or 2SC2166. Changing the coil's tap point and turns count by two or three may be necessary to achieve oscillation with these transistors, so dink, experiment, learn, and enjoy! That's the purpose of this project!

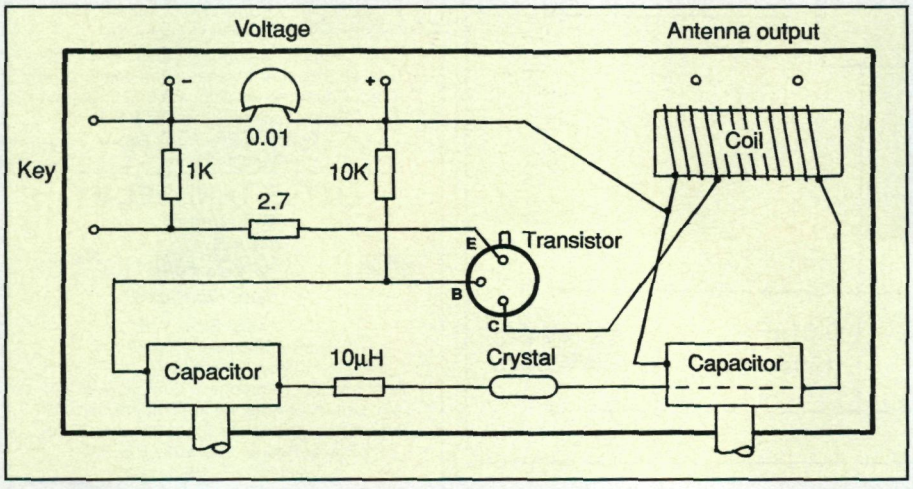

Fig. 4– Diagram of the Super Mite illustrating typical layout of parts and wire runs for easy assembly.

Coil Details

The coil plays a major role in this mini-rig's performance, so I built two versions with different sizes of coils to ensure good flexibility in assembly. The first coil was wound on a $1^{1}/_{4}$ -inch diameter form (a pill bottle) with No. 18 solid, insulated hook-up wire. The second coil was wound on a Wal-Mart-obtained $^{5}/_{8}$-inch diameter wood dowel using No. 22 enamel-coated copper wire (both forms were 2 inches long, or tall). A few more turns of wire were necessary for obtaining resonance with the smaller diameter coil; otherwise operation and output power was the same. Drill two holes in each end of your selected form to hold/secure tank-coil ends after winding. The antenna coil for either form uses more No. 18 insulated wire. It is wound over (and with its turns spaced evenly along) the tank coil. The antenna coil is held in place by threading its ends through holes in the perfboard (for wood form) or by a single twist of its leads (for pill-bottle form). Coil winding counts for each band are shown in fig. 2. Adding or

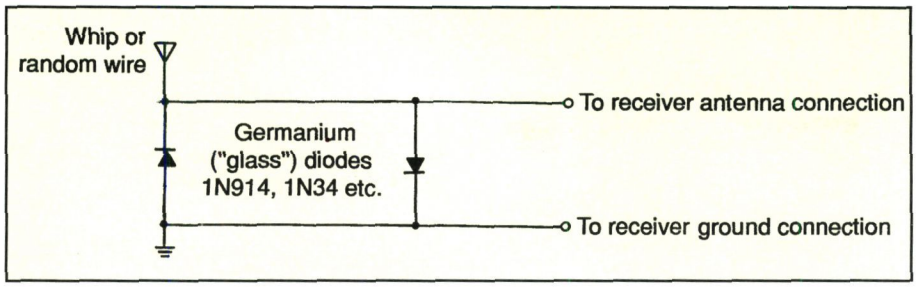

Fig. 5– Arrangement for connecting dual germanium diodes back-to-back for receiver "front end" protection. When a strong signal (above .3 volts) is sensed, diodes conduct and short antenna wire to ground. (Discussion in text.)

unwinding one or two turns to achieve oscillation or peak output may be necessary in a few cases, but be sure your wiring is correct before experimenting with coil turns or taps.

Assembly Tips

As a success-ensuring measure, I suggest starting by building the basic circuit first (less VXO and antenna pickup coil and using a single 9-volt battery as shown in fig. 3). After proper operation is confirmed and you are familiar with how the Super Mite acts, add (one at a time) the VXO, antenna coil, and dual battery mod. Should the rig stop working, you will then know where to check first for problems. The wood-dowel-type coil lies in the horizontal position. Its wire leads are threaded through the perfboard and pulled tight to hold it in place. The pill-bottle coil will stand vertically half on and half off the perfboard. Small dabs of Super Glue® are used to secure the pill bottle and plastic-case tuning capacitors to the perfboard.

A general parts layout and wiring guide is included in fig. 4. Strive for accuracy during assembly. Remember the "short" (5-turn) side of the coil connects (along with the 10K-ohm resistor) to positive voltage, the "long" side (most turns) connects to the crystal, and the tap connects to the transistor's collector. The most common error folks make is interchanging these three wires and/or not scraping enamel from copper wire. Scrape it shiny clean!

Check Out and Operation

After assembly carefully recheck your wiring, looking not for what's right, but for what's wrong. Then apply power. Listen for the Super Mite's signal on a nearby receiver, bearing in mind that even without a VXO, it may be 5 or 10 kHz above or below its crystal's frequency if the variable capacitor is not tuned to resonance. If necessary, jump or short out the 1K-ohm emitter resistor (use only one 9-volt battery, do not hold down the key for more than 5 seconds, and install a heat sink on the transistor). Once the circuit is oscillating, re-tweak the tuning capacitor for the cleanest sounding signal consistent with high output (as read on an SWR bridge or FSM) and then compliment yourself on a job well done.

Earlier I mentioned pairing the Super Mite with a low-cost AM-type shortwave receiver for portable hamming. The "easy approach" here is using a dipole or Delta Loop (think *big*!) with the transmitter and a whip or random wire with the receiver. Remember to protect the receiver's "front end" during transmit by shorting its antenna and ground connections, or by adding a diode limiter circuit as shown in fig. 5. The germanium diodes will not affect normal reception, but will shunt signals above 0.3 volts to ground. Finally, remember you can raise or lower the BFO's receiver injection level by changing the value of the 1K-ohm emitter resistor. Each case may differ, but values between 800 (a high BFO level) and 4700 ohms (a low BFO level) work for all, with 1K ohms being a good "general" or "starting" value.

The Parts Pack

As you probably surmised, our Super Mite is more of a homebrew fun project than a formal kit (you route wires and alter/modify resistor values to fit your needs rather than insert component leads in marked holes). Bearing that fact in mind (and also sensing many amateurs will consider assembling a Super Mite as their first QRP project), I expanded on several fine points in this discussion to help ensure your first-time success.

I have also gathered a bundle of required components and put together some parts packs both with and without perfboard and/or coil forms to help you get started homebrewing at the lowest possible cost. Be aware I am also planning to move farther south toward the land of sand and sun during the next few months, so my postal and personal e-mail addresses will soon change. Meanwhile, drop me an e-mail at <k4twj@cq-amateur-radio.com> and I will forward more details (and my new addresses) to you. May the force of good signals always be with you!

73, Dave, K4TWJ