Number 32 on your Feedback card

HOMING IN

Radio Direction Finding

Photo A. WA6DLQ's control box contains the attenuator control and read-out in the upper right corner, plus an external S-meter, noise meter, and LED-bar meter.

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Handling Strong Signals

In the last two columns, you've seen how a beam or quad makes a simple, high performance VHF RDF antenna, and how easily you can put one together. But before you're ready to go out and bring home the trophies, you'll need to do a little more work.

At the start of the hunt, the hider's signal may give your receiver only a fraction of a microvolt, but when you get in close, the receiver could get pounded with nearly a volt of RF, even if the hidden T is running low power. The S-meter circuit on your VHF FM rig doesn't have nearly that much range. It probably reaches full scale at 10 microvolts, giving only about 30 dB from minimum to maximum. That's good because it's easy to see the meter peaks when you swing the antenna, but it's bad because the meter will stay pinned when the signal is strong.

Without some sort of low sensitivity receiving system, you may think you're close to the hidden T when you're actually many miles away. You certainly won't be able to get close enough to the hidden T to identify it. That's where the attenuator comes in. This is a device that goes between the antenna and the receiver to reduce the signal level down to within the range that the receiver and its S-meter can handle.

External Attenuators

Attenuator boxes have been around for a long time and have plenty of uses outside of RDF work. For RDF use, connect it in the coax line between the antenna and the transceiver. You can buy nice commercial ones if you have money to burn, or you can readily make your own with ordinary carbon resistors, toggle switches, and a copper-clad board.[1] Most local hunters here in California use these simple step attenuators. There are caveats here, however. You have to remember to switch all sections off before you transmit. If you forget, you may burn out the resistors and put yourself out of the hunt. Also, very strong signals can go around an external attenuator and enter directly through the receiver case or the coax between attenuator and receiver, pinning the S-meter.

There is another kind of easy-to-build external attenuator that uses sliding pieces of brass tubing. It was described a couple of months ago here in *73 Magazine*, and there is also a version in the T-hunt book.[2] Although it can't get cooked if you build it without any matching resistors inside, transmitting through it could ruin your day because it presents a very bad match to your transmitter at some settings. If the rig's high-VSWR shutdown circuit is working OK, there's no problem. But I'd rather risk some burned up resistors than a burned out final amplifier.

The Internal Solution

If you're not afraid to open up your receiver and do some minor augmentation surgery, you can have the best attenuation scheme. It gives full control over sensitivity and you can transmit safely at any time. As a bonus, you'll get more attenuation range than is possible with an external attenuator, because there's no RF leakage problem.

Vince Stagnaro WA6DLQ, a successful local hunter, designed this internal attenuator system, based on earlier work by Peter Bertini K1JZH, Russ Andrews K6BMG, and others. Vince's design is really "deluxe" because it features a rotary control that is calibrated in 10 dB steps. It's fast and easy to use, and the calibrated read-out will help you estimate your relative distance to the hidden T.

You'll need a copy of your receiver schematic before you start. Attenuation is accomplished by reducing the supply voltage on the early RF stages of the receiver. Mods are made only on the DC portions of the circuit, so receiver alignment is not affected. The only connections between the control box and the receiver are the voltage control lead and ground. When you're not hunting, disconnect the control box, and the receiver will operate at full gain.

Install attenuator control transistor Q1 and associated components R1, C1, and C2 on a very small piece of perf board inside the receiver case. Lift the B+ side lead of resistors that are in series with MOSFET drains of the stages to be controlled and connect to the emitter of Q1, as shown in Figure 1.

Vince built his unit for use with a Kenwood TR-7950 transceiver and found that he got best results by breaking the supply line to the RF preamplifier (R7), first mixer (R15), and first IF amplifier (R21) stages. You'll probably find that controlling the same stages on your own receiver will work well. You should not need to control stages beyond the first IF amplifier.

Drain resistors for RF/IF stages are usually in the range of 22 to 100 ohms. Make sure that they supply B+ to both the FET drain and the gate-2 voltage divider, if used. Recent sets such as the TR-7930/7950 and IC-25 are configured this way. The gate-2 divider current does not pass through the drain resistor on some older rigs such as the TS-700A. On those sets, the top of the gate-2 divider resistor pair must also be connected to the controlled voltage line.

Some receivers are different because they have two RF preamplifiers or a passive mixer. Experiment to see which stages need to be controlled on these units. Do not reduce the supply voltage to local oscillator stages. If you have trouble figuring out your receiver schematic, get a local techie ham to help you. Just give a call on a nearby repeater, and they'll probably come out of the woodwork.

Working in today's tiny transceivers can be a bit cramped. Unless you are skilled in the necessary special techniques,

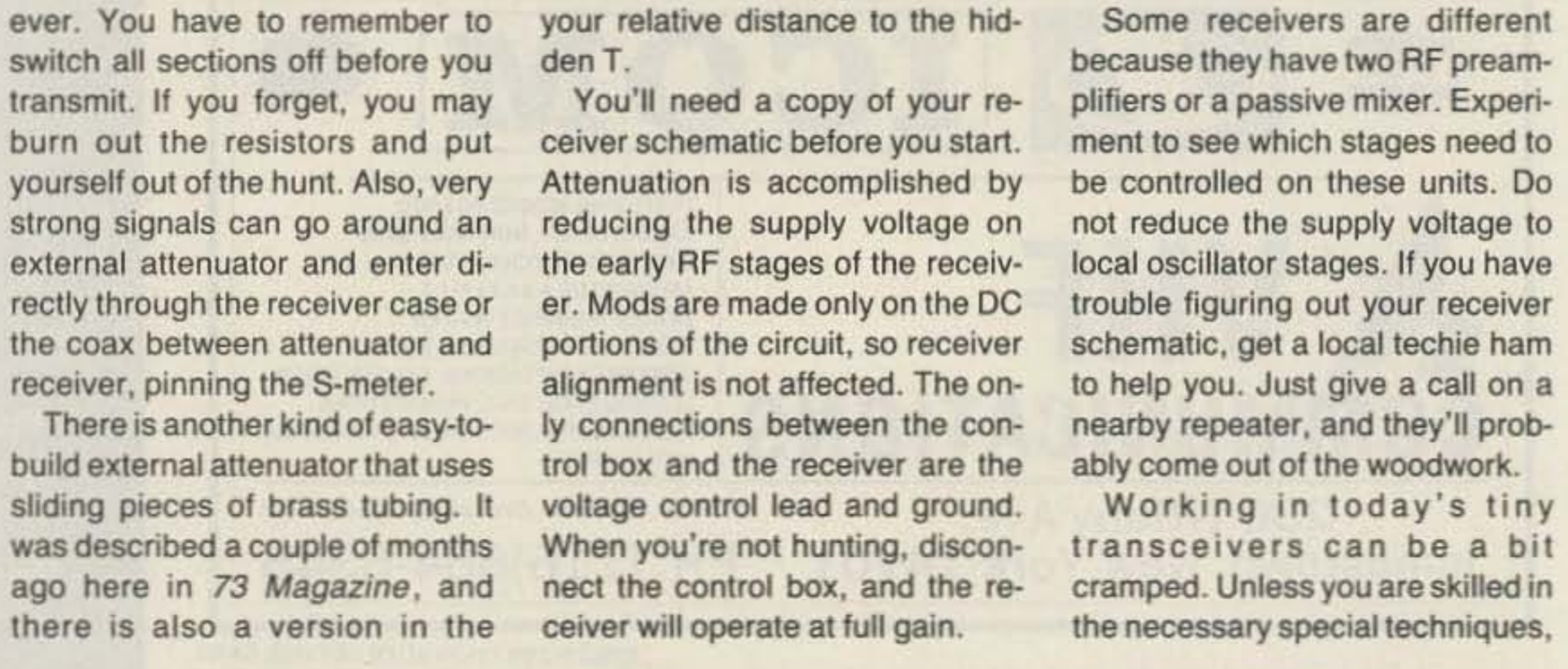

Figure 1. Circuitry in dashed lines is added inside the receiver to control the supply voltage of early stages. Typical stages of modern VHF-FM receivers are shown in block form.

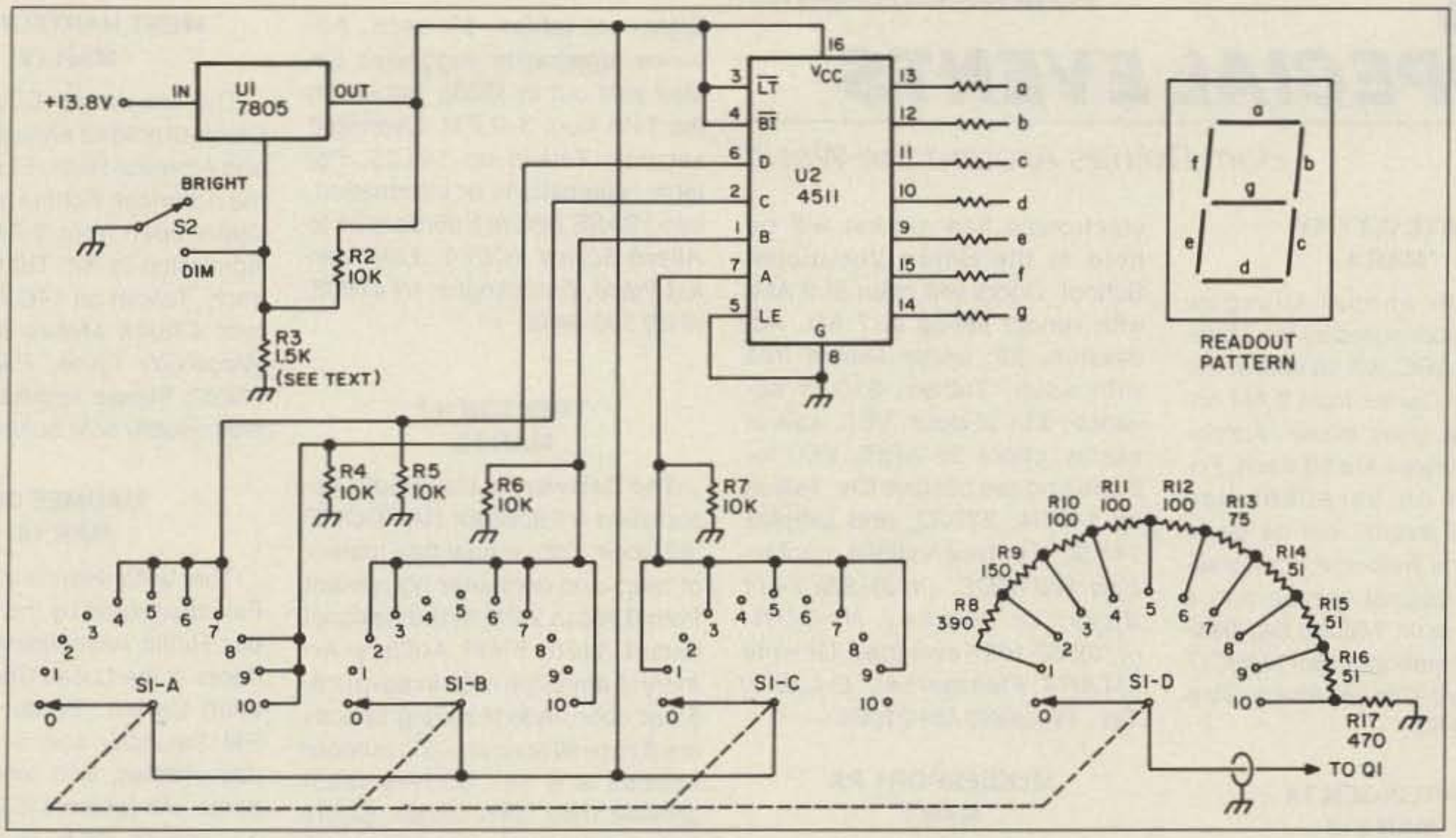

Figure 2. Schematic diagram of the attenuator control unit, which goes in an external box on the dash.

avoid transceivers that use surface-mount components, such as the Kenwood TM-221/321 series and TM-621/721 dual-banders. Remember that the radio will get plenty of shock and vibration in mobile hunting use, so take your time, be neat, and tape all loose wiring carefully to prevent shorts.

Some sets, however, seem to be custom-designed for this kind of modification. The ICOM IC-22U and Clegg FM-DX have one jumper wire that connects B+ voltage to the preamp, first mixer, and first IF stages. Find that jumper and break it, connect the Q1 circuit, and you're in business!

If the hunt rules require closing in on foot, you'll need a field strength meter or a battery-powered, hand-held rig with internal attenuation. You can modify a handie-talkie, but you'll need the hands of a surgeon. A good choice for a rig to modify for this purpose would be one of the older crystal portables, such as the Kenwood TR-2200 or Drake TR-33. They're easy to work on, and you can find inexpensive ones in the used market. Consider deleting the read-out, replacing the rotary switch and fixed resistors with a potentiometer, and mounting the pot inside the rig to make a one-piece, hand-carried "sniffer."

The Control Box

I suggest you build or buy a nice large box (see Photo A) for the attenuator control unit. There are plenty of other T-hunt gadgets, such as a noise meter, remote S-meter, audio S-meter, and DSB detector that you may wish to put inside later. Mount the box firmly to the dash in a position that allows easy reading and viewing, but does not obstruct road vision.

If your transceiver has a multi-pin accessory connector, hooking it to the control box is a snap. Otherwise, drill a hole in the rig to add a connector, or rewire a connector you don't use now, perhaps the external speaker jack. While you're at it, plan ahead and make provisions for wiring in other features you may want to add later, such as the remote S-meter and DSB detector.

All parts in Figure 2 are mounted in the control box. The circuit of S2, R2, and R3 force the output of U1 to be either +12 volts to give bright LED read-out indication for daytime hunts, or +5 volts for dim read-out on hunts at night. Select R3 to give approximately +12.2 volts at U1 output in the BRIGHT position. Power for the control box can come from the cigarette lighter socket.

Rotary switch S1 has eleven positions and four decks, such as Centralab PA1014 (shorting) or PA1015 (non-shorting). Position 0 gives no attenuation (full receiver gain) with the LED read-out blanked. Position 1 gives 10 dB gain reduction and a "1" indication on the read-out, and so on up to position 10, which is 100 dB attenuation and "0" on the read-out.

Q1 is a Motorola MPSA14 Darlington transistor. It's a common part, but if you can't find it, substitute a NTE46 or ECG46 standard replacement transistor. All resistors are quarter-watt parts. The single-digit LED read-out is a common-cathode type, such as Radio Shack 276-077. Values of R8-R17 are for WA6DLQ's TR-7950 installation. If you use a different receiver, try Vince's values first. For the most accurate steps, go through the calibration procedure and determine your own values for R8-R17.

Calibration

To accurately calibrate the internal attenuation system, you'll need a signal generator with variable output on the selected band and an accurate RF attenuator for reference, either built into the signal generator or external. Hook the signal generator through the reference attenuator to the input of your modified receiver. R8-R17 should not be installed at this point. Set the reference attenuator for 100 dB and power up the receiver and attenuator control box.

With the rotary switch on your new internal attenuator set to zero, adjust the signal generator output control for a mid-scale reading on the receiver S-meter. Now set the reference attenuator for 0 dB and turn the rotary switch to position 10 ("0" on the read-out). Select a value for R17 that gives the same mid-scale reading on the receiver S-meter, and solder it in.

Set the external attenuator for 10 dB, turn the rotary switch to position 9 ("9" on the read-out), select a value for R16 that gives the mid-scale S-meter reading, and install it. Next, set the external attenuator for 20 dB, turn the rotary switch to the next position ("8" on the read-out), select a value for R15 that gives the mid-scale S-meter reading, and install. Continue in the same fashion through the rest of the rotary switch positions, ending by selecting R8 to calibrate position 1.

This internal attenuation method works very well with MOSFET or junction-FET RF amplifier stages, used in almost all VHF rigs now being sold. Many older sets use bipolar transistor stages instead of FETs. Voltage reduction doesn't give good results with these rigs, but raising the voltage on the ground side of the transistor emitter resistors usually works well. This technique is described in the T-hunt book.

With your gain antenna, S-metered receiver, and attenuator, you have all the necessities to go hunting on your favorite VHF band. However, there are a number of additional devices that can make you more successful. In the next few months, we'll discuss tricks for antenna polarization selection, antenna mounting, and noise metering. 73

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[1] Moell and Curlee, *TRANSMITTER HUNTING–Radio Direction Finding Simplified*, TAB Books #2701, p. 56. Available from Uncle Wayne's Bookstore.

[2] Cloninger, W.C. "Super Simple Attenuator," *73 Magazine*, January 1989, p. 14.