COURTESY SRI

# Simple Equipment for HF Fox Hunting

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Figure 1—String along with the authors as they show you how to build a simple, yet effective HF direction-finder! This photo shows the complete setup: portable shortwave receiver on a metal plate, with a Faraday shield around the antenna for close-in work. An incoming signal is nulled when the whip is pointed directly at or directly away from it.

Glen Rickerd, KC6TNF, described simple and inexpensive equipment for VHF direction finding.[1] His method used a hand-held transceiver inside a hollow conducting cylinder held vertically near the operator's body. Our HF direction-finding system uses the same approach, even at wavelengths 10 times greater. In addition to tracking down transmitters operating from 3 to 30 MHz, you can use this project to locate local sources of radio-frequency interference (RFI). Transmitter ("fox") hunting is not commonly practiced at HF, probably because of the size and relative complexity of equipment for this frequency range, compared to that used at VHF.

Our equipment uses a portable HF receiver (a Sony ICF-7600 is shown) that is sensitive and has an internal BFO. When properly mounted on a small metal plate and with its whip antenna extended, this receiver forms a rotatable directional system with a null like that of a conventional loop. Figure 1 is a photo of the device in use; Figure 2 shows how the receiver and whip are mounted on the plate. This device works best with ground wave signals, but will also null sky wave signals under some conditions. (Sky wave signals don't always travel in direct paths, and may also be subject to scattering, which makes it difficult to achieve a well-defined null. —*Ed.*) For sky wave signals the level of performance is about equal to the time-honored shielded, single loop.

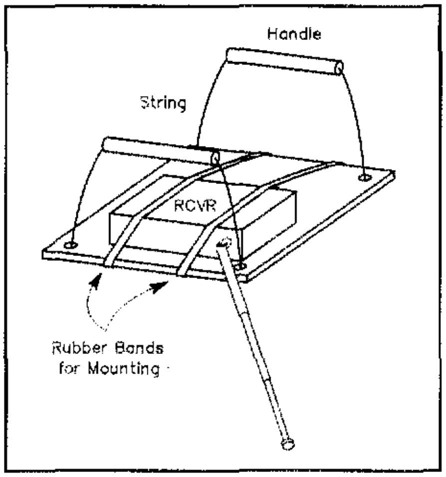



Figure 2—Receiver mounting on the conductive plate. The receiver whip is extended along the diagonal of the square plate, and should always be in the plane of the plate. Use rubber bands to hold the receiver in place. The conductive plate can be made from aluminum, brass, copper or copper-clad PC-board material.

## Construction and Assembly

Figure 3 shows how the receiver's whip is pointed on end with respect to a radio wave. The wave has parallel fronts, so that the whip is aligned so as to be perpendicular to the electric field. No RF current is induced in the whip, except as a result of field distortion caused by the radio itself. If the reradiated energy is electrically symmetrical with respect to the whip, however, the antenna will still null the signal. Fortunately, the radio can be combined with a conductive plate in such a way that the reflected energy is symmetrical. In the null direction (the direction of whip, radio and plate), neither the incident wave nor backward-directed symmetrical receiver scatter induce signal energy into the whip and the radio. The result is a clean null if there are no additional signal sources present.

Modern portable SW receivers are thin enough to mount face up on the metal plate. When grounded to the plate, the radio effectively becomes part of the plate. (For best results the receiver ground should be connected directly to the plate. Of course, receiver-to-plate capacitance will—at least partially—provide a connection in any event.) Electromagnetically, the plate-

[1] G. Rickerd, KC6TNF, "A Cheap Way to Hunt Transmitters," *QST*, Jan 1994, pp 65-66.

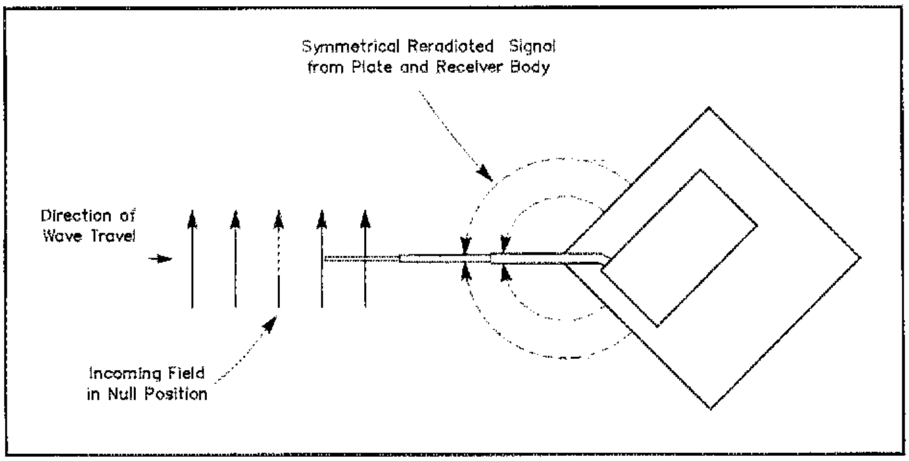



Figure 3—Field lines of the incoming wave are perpendicular to the whip and induce no voltage in it. When the receiver is mounted on the conductive plate, the receiver is symmetrical with respect to the whip. Parts of the end-on incoming signal wave are uniformly scattered and don't upset the antenna null by inducing voltage into the whip.

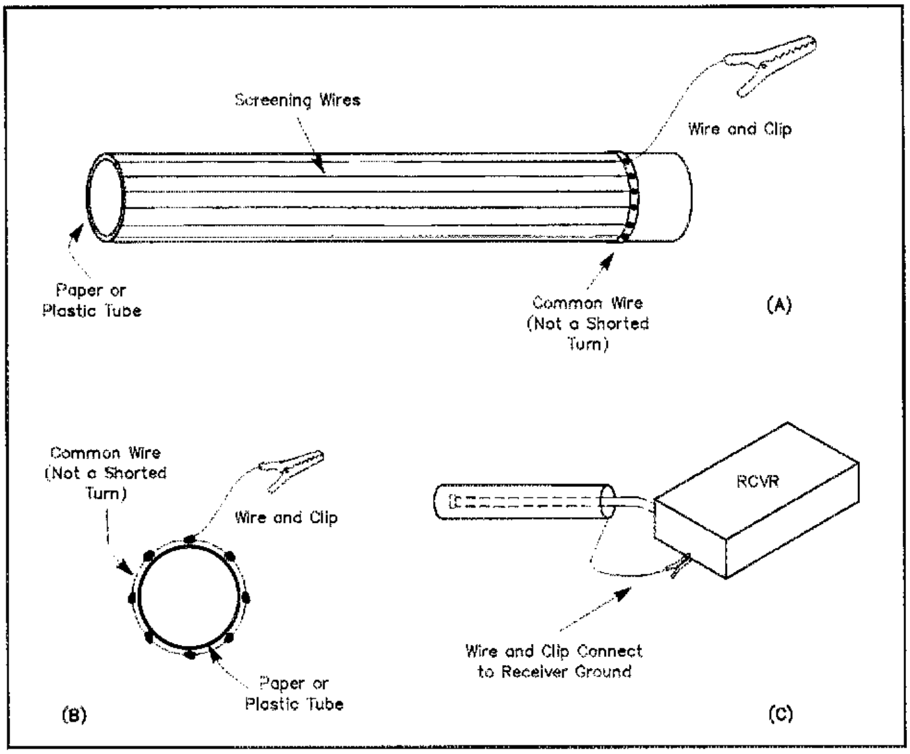



Figure 4—A Faraday shield over the whip reduces signal pickup and makes directional nulls more apparent. Wires in the shield are insulated from the antenna by the hollow paper or plastic tube (about 1-inch diameter) but connected to the receiver ground (through a clip connected to one side of an external power or antenna connector or headphone jack). Shield construction details are given in the text. A is a side view of the shield, B is an end view and C shows the shield in place.

plus-receiver of Figures 2 and 3 is essentially equivalent to the plate alone. A good null is obtained when the incident wave is aligned with the receiver whip, because the wave reradiated from the receiver also has a null in that direction. When DFing, the plate, receiver and whip must always maintain the same mechanical position with respect to one another. The whip should always lie along a line formed by an extension of a line drawn diagonally across the plate and in the plane of the plate.

Whip length is not critical. A longer whip will provide more signal to the receiver, however, the arrangement may become mechanically awkward. If the whip is too short, bearing accuracy suffers along with sensitivity. The size and thickness of the plate (which can be made of any convenient metal) is not critical. The plate can even be made of nonconducting material, such as cardboard or wood, and covered with aluminum foil. Arranging for the radio and plate to form a symmetrical structure is complicated by the unsymmetrical mounting of whips on most portable receivers. A plate area 20 to 50% larger than that of the radio usually permits a symmetrical layout.

The strings supporting the plate and radio (Figure 1) must be nonconducting. The device can be rotated back and forth like a puppet, while being held a foot or so from your body. Attach the radio to the plate with rubber bands attached to cup hooks. Most adjustments can be made from the top of the receiver despite the rubber bands, which easily can be removed when the receiver is needed elsewhere.

## Operation

In the minimum-response position, the whip points in the direction of the station (or its reciprocal). In finding a null, accuracy can be improved by rotating the device back and forth across that bearing and forming a mental average of the null position. Although the plate can be tilted slightly if desired to improve results, horizontal orientation seems generally best. To average out local anomalies, we recommend you make measurements at various locations at least several feet apart.

One other circumstance needs to be taken into account. The human body produces an echo, just as does the receiver on its plate. Fortunately, body scatter falls off with distance just as rapidly as receiver scatter. (Both represent "near fields.") Depending on circumstances, scatter usually becomes unnoticeable at distances of 3 to 5 feet. Faraday screening of the whip reduces this distance appreciably. Otherwise, the effect of body scatter can be minimized by the same expedient used to minimize the effect of receiver scatter. Since the body is reasonably symmetrical, it will not appreciably affect bearing accuracy when located along a line oriented toward the distant transmitter and located either downstream or upstream of the receiver and its whip. A good procedure is to hold the receiver with its whip pointing perpendicularly outward from the body, and then to rotate body and whip together. If you place the device on a turntable, the bearing is readily found by trial and error, and by keeping your body in the right position and as far from the plate/receiver as possible.

The swinging plate device works particularly well when the signal is weak. The null direction is indicated either by an increase in noise, or by a change (normally a weakening) of any modulation. It is necessary to infer strength changes in this indirect way because the RF gain control of most portable shortwave receivers isn't accessible. By adjusting whip length, however, you can somewhat control sensitivity.

Sometimes the signal becomes so strong that, even with the whip retracted to the last section, the gain changes can no longer be distinguished. You can further reduce sensitivity by holding the equipment close to the ground. A more elegant way to attenuate the received signal is to cover the whip with a partial Faraday shield. Make the shield in the form of a concentric cage of equally spaced parallel wires grounded at one end to the plate or the receiver chassis (Figure 4). Cage diameter and length are not critical. About ½ to 1 inch diameter is about right. The shield reduces the amount of RF reaching the whip, but doesn't significantly alter directionality, because the whip and the shield are essentially parallel and concentric. You can make the shield from hookup wire taped to a paper cylinder that slips over the whip without electrical contact. A shield of eight wires introduces an attenuation of about 15 dB. With more wires, the attenuation is proportionally increased, as the shielding becomes more effective. Perhaps another 10 to 15 dB of attenuation is possible with more wires.

A different technique is to make use of body absorption, in the manner described by KC6TNF in Note 1. Retract the whip antenna to the last section, install the Faraday shield and hold the entire assembly vertically in front of your torso. It seems to be important to orient the radio perpendicular to the body. As you and the equipment turn, you'll find the null. This technique is useful for checking results obtained with radio, plate and whip horizontal. This technique will also help determine which null actually points toward the oncoming wave.

In some cases the received signal may become so strong that it leaks into the radio, thus spoiling the directional response. When this happens, place the radio inside a metal cylinder for further attenuation.

### Conclusion

Fox hunting with simple, lightweight equipment is possible at HF, with standard, unmodified battery-powered receivers. Battery-powered QRP transmitters would be ideal "foxes." (This equipment will also be helpful when nearby hams' vacuum cleaners are accidentally transmitted on 20 meters!—*Ed.*)

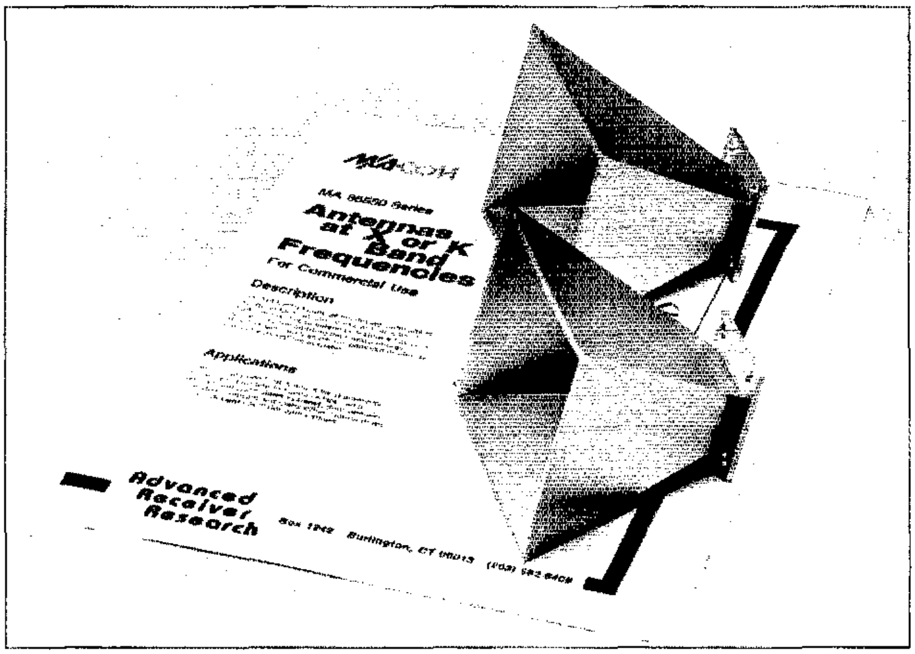
# New Products

### TEN-TEC KITS

◊ The hams at Ten-Tec present their new line of T-Kits. These include a 2-meter power amplifier for hand-held transceivers that offers 1 to 5 W input with 20 to 35 W output ($74); the Argonaut II RF deck for HF QRP operation (5 W at 160 to 10 meters) ($95); desk ($49) and hand-held ($29) replacement microphone kits for a variety of transceivers; a microprocessor-controlled, 10-memory 2-meter FM transceiver with LED display and 5 or 35 W output ($195); HF/VHF SWR bridge and wattmeter for 1.8 to 30 and 144 to 148 MHz ($49); module boards; antenna products; enclosures; SWL equipment; and more. Most kits are also available factory wired and tested at an extra charge. T-Kit, a Division of Ten-Tec Inc, 1185 Dolly Parton Pkwy, Sevierville, TN 37862-3710; tel 800-833-7373 or 615-453-7172; fax 615-428-4483.

### RF-SHIELDED BOXES

◊ Frustrated by home-built devices that leak stray RF or clock signals, disrupting the operation of other circuits? Keep the RF from getting into or out of your project with an RF-tight, hot tin-plated steel box. SB-series shielded boxes come in many compact sizes, from 2.1×1.9×1.0 inch to 6.4×2.7×1.1 inches, at retail prices from $4.50 to $13.20. Feedthrough capacitors cost 85 cents to $3.50 each. There's also a complete line of modular construction boxes, rack chassis, metal cabinets, dual-slope cabinets, and "Rackem 'N' Stackem" boxes and racks. Sescom Inc, 2100 Ward Dr, Henderson, NV 89015; tel (orders only) 800-634-3457, fax (orders only) 800-551-2749; info 702-565-3400; tech line 702-565-3993; fax 702-565-4828.




### MICROWAVE ANTENNA

◊ It's easier than you think to experiment with operation at 10 GHz, especially with the popular, low-cost MA86551 X-band antenna (pictured above). The horn antenna has been retooled for better performance and value. It's made of injection-molded ABS, and electrodeposited with 0.0004-inch copper and a 0.0003-inch nickel final plating for a bright, mirror-like finish. It covers 8 to 12.4 GHz, with a center frequency of 10.525 GHz, and a 25° E- and H-plane beamwidth. The integral flange mates with UG-39/U. Retail price is $20. Jay Rusgrove, W1VD, Advanced Receiver Research, Box 1242, Burlington, CT 06013; tel 203-485-0310.

### SATELLITE MAGAZINE

◊ The publisher of *Monitoring Times* announces the forthcoming publication of the world's first full-spectrum satellite monitoring magazine, *Satellite Times*. Managing editor Larry Van Horn, N5FPW, says that the bimonthly magazine will cover all phases of satellite communication, including amateur, military, commercial, broadcasting, scientific, government, personal communication and private systems. Charter subscriptions are (US funds) $16.95 (US), $23.95 (Europe), $26 (Europe via air mail). Grove Enterprises, 300 S Hwy 64 W, PO Box 98, Brasstown, NC 28902; tel 800-438-8155 or 704-837-9200; fax 704-837-2216.