

Amateur Radio Direction Finding

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Introduction

Amateur radio direction finding (ARDF)—also called Radio Orienteering, foxhunting, or transmitter hunting—can take many forms. The game described here has been standardized and fostered by the International Amateur Radio Union since about 1978. The object is to locate and visit on foot each of up to five transmitters concealed in a wooded area in as short a time as possible by using a directional receiver to obtain bearings to the transmitters. The transmitters (foxes) all transmit on the same frequency, but take turns transmitting a unique signal for one minute and are silent for 4 minutes while the others transmit.

The skills needed to succeed include obtaining accurate bearings with the receiving gear, navigating through the wooded area using map and compass, and devising a strategy to visit the required sites in the minimum time.

Course layout, rules

See Figure 1 for a (schematic) course layout. The hidden transmitters, foxes, will be located so that the associated marker flag (control) can be seen when the hunter is within about 3m of the transmitter; they will be at least 400m apart; no fox will be nearer than 750m from the start. A homing beacon on a different frequency from the foxes is located at the entrance to the finish corridor.

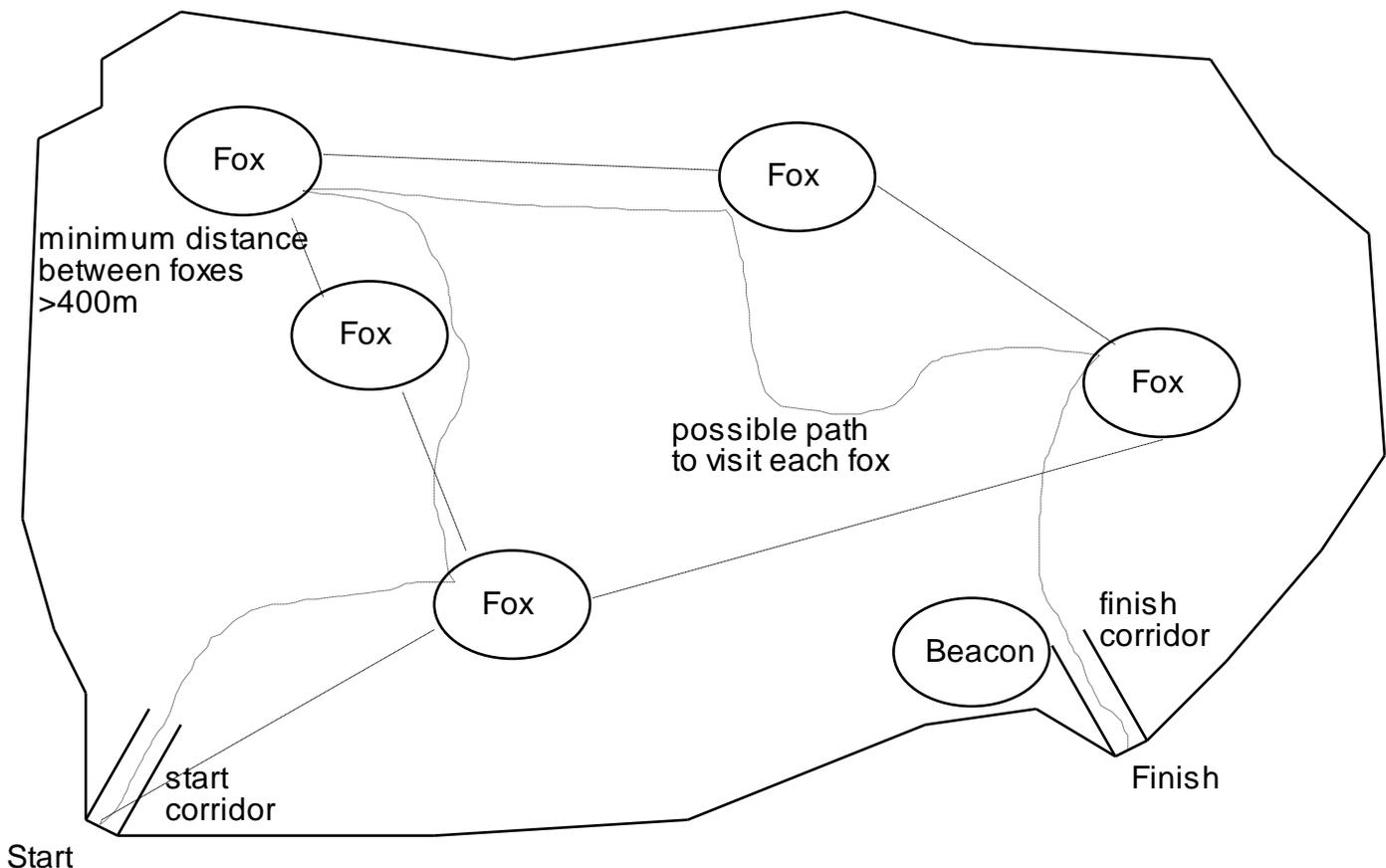


Fig. 1 - ARDF Course Layout

Each fox will transmit a signal with a unique pattern that identifies which transmitter it is. The standard patterns are incidentally slow Morse code characters, but you do not need to know that to understand which fox is on. The signals have two long (dashes), three long (dashes), then followed either by one short (dot), two short, three short, four short, or five shorts to indicate fox 1, 2, 3, 4, or 5 respectively. In addition to the transmitted patterns, a fox can also be identified by the time it is on: fox 1 transmits in minute 1, fox 2 in minute 2, and so on. The beacon transmitter sends two long, three long, continuously. Finally, to comply with radio regulations, the transmitters will also send an amateur radio call sign in rapid morse code at the beginning of each transmission.

Prior to any competitor being on the course or starting of the foxes, it is usual to gather the receivers in a quarantine area near the start. When there are many competitors, they will be divided into groups of 3 to 10 and the groups start at 5 minute intervals to spread competitors out in time. A few minutes before the start, the competitors will receive a map of the area and any last-minute info about the course and will pick up their receiver from the quarantine. The receivers must remain turned off while awaiting start.

The hunter will leave the start position when instructed to do so, go to the end of the marked start corridor (about 100m long), turn on the receiver after passing the end of the corridor and begin to locate the foxes. At each fox, the hunter will punch his score card with that fox's unique punch to prove having visited that fox. After locating all the foxes required, or as many of them as there is time for, the hunter exits the course via the marked finish corridor.

The time elapsed from leaving the start position until reaching the finish line is recorded along with the number of transmitters successfully located to determine the hunter's standing with respect to others in his category. The standing is first among those finding all of the required foxes in the shortest time, then among those finding one fewer fox, etc. Those not returning to the finish within the maximum time limit (2 hours, typically) are disqualified.

Operating the ARDF Receiver - General

The course should be setup so that all of the foxes are audible from the end of the start corridor, so as soon as the receiver is turned on you should be able to tune it to the foxes' frequency. For some receivers (Altai) tuning is fairly touchy, and may need to be adjusted from time to time.

Since you need to be able to discern changes in signal strength as the antenna is swung around, it's generally a good practice to keep the receiver attenuator adjusted so that the signal is fairly weak. This setting avoids receiver saturation, and may help lose some unhelpful responses in the antenna pattern.

Many receivers that are purpose-built for ARDF will provide an 'audible S-meter' to take advantage of the ear's better ability to discern small pitch differences compared to small loudness differences. This feature will have an audio output tone that varies in pitch as the signal level changes. Higher pitch means louder signal.

Especially at VHF the signal from the transmitter may travel along multiple paths. The effect of this propagation may be to give a bearing in the wrong direction--along a reflected path rather than the desired direct path. Also, the multi-path signal may vary in amplitude with movement over distances of about a wavelength. To guard against erroneous bearings from multi-path, it's common to get a trial bearing then take a step or two to the side and make sure the bearing is still the same. Alternatively, move until you're in a maximum signal zone and take a bearing--but this position could still be affected by multi-path. Generally, the best strategy is to take and plot many bearings from different locations on the course. The assumption is that most of them will be right.

Russian Altai antenna/receiver

In addition to the usual (tuning, attenuator) controls, the Altai has a 'tone' switch that adds a tone modulation to the incoming signal. This function is mainly to help locate unmodulated signals. However, since the Altai is an AM receiver, and the foxes we will be using have frequency modulation, turning on the tone might be helpful. Most users do not use the 'tone' switch.

The 'audible S-meter' function in the Altai is push-button operated, and is only effective when very near the fox. It is also very loud, so if you try it remove the headphones away from directly over your ears.

Finally, the Altai has a 'threshold' switch that decreases the sensitivity of the receiver by requiring a larger signal at the detector. This switch may help sharpen bearings by allowing only the maximum level to pass the detector as the antenna is swung around. Again, most users do not use this feature.

Active Attenuator with handheld

A useful minimal configuration that can be put together fairly simply consists of a directional antenna (3 element Yagi), an 'active attenuator', and a 2m handheld. See Figure 3.

The active attenuator (Figure 2) is a simple oscillator/mixer with variable mixer injection level—this setup moves the received frequency up or down the band by the oscillator frequency (500 kHz, 1MHz are common) where it's level can be adjusted without interference from the direct signal. There are many examples of these gadgets around and someone probably has a kit available. The one I like best was described in November/1992 issue of QST (and recent ARRL handbooks—e.g., 2009 edition, page 13.30).

Similarly, there are many home-brew examples of Yagis made with measuring-tape elements. These tape-element antennas have the advantage of being robust in the woods, but any directional antenna will serve.

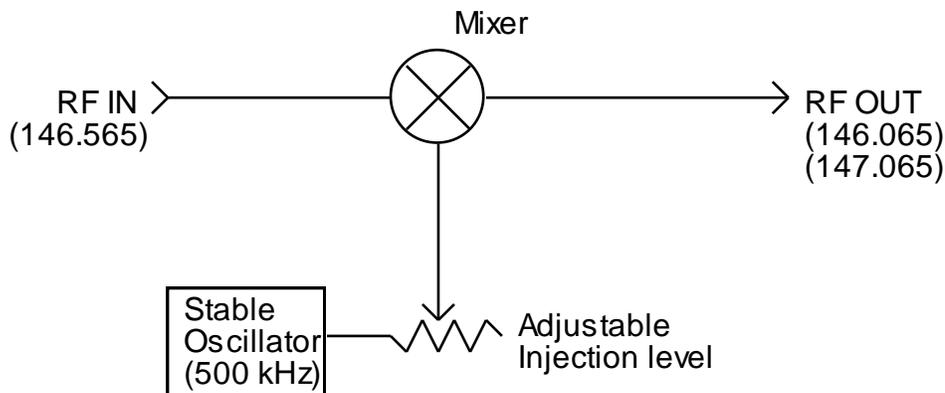


Fig. 2 – Active Attenuator block Diagram

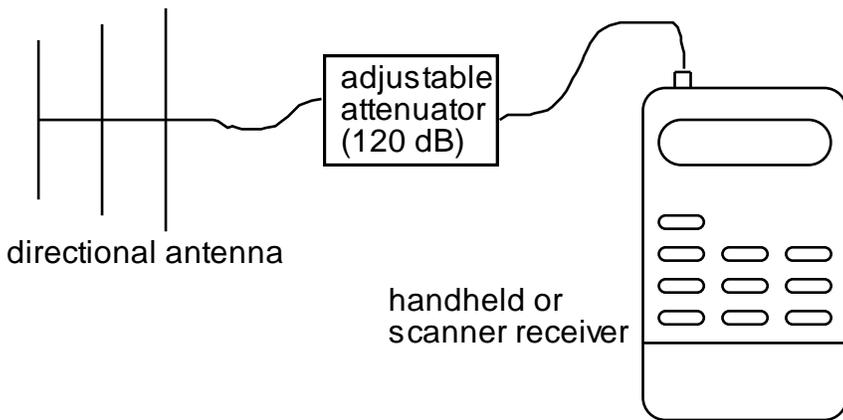


Fig. 3 – ARDF minimal system block diagram

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This purpose-built ARDF receiver has many features that can help the experienced user, but may be confusing for the beginner. The advice here is to assume that the receiver has been configured so that it will work OK for the beginner when it's turned on. The unit is turned on by pressing the M key and it's turned off by pressing and holding the M key. When the receiver is turned on, it can be set to the fox frequency and a useable mode by selecting one of the memory preset keys, e.g. 6. This selection puts the receiver into the mode that was decided by the person setting it up, and it should be useable by the first-time hunter.

The attenuator function is automatic, and the current setting appears in the display as 0..8, with 0 being most sensitive or responding to weakest signals. An indication of 8 means you are very near the fox.

Depending on how fast you move, the multi-path environment, or perhaps your preference, the automatic gain-ranging may be distracting. You can temporarily freeze the current gain setting by pushing the R key. Pushing the key again releases the setting to the automatic control.

Strategies

At the start, it is a good idea to move away from the immediate end of the start corridor to take your first set of bearings so that others in your group of starters are not 'helped' by seeing your actions.

If the terrain permits, bearings obtained while standing on high ground tend to be more reliable.

Take bearings on all of the foxes you need to find as often as you can to build up a picture of probable locations. It is a good use of the time waiting for a nearby fox, that's just gone off as you were crashing toward it, to come back on.

It is generally quicker to navigate to a fox location by using the trails than it is to follow a bearing through the bush, but only if your map-use skills let you find the trails.

It may be helpful (say during the few minutes before you're to start) to mark off exclusion areas on the map—there will be no fox located within 750m of the start, so a circular region with radius 750m centred on the start

does not need to be considered. There may be areas adjacent to the course that must not be entered. When a fox is found, a circular region with radius 400m will not contain another fox.

Pay attention to the time. It is better to return before the limit having found fewer than necessary foxes than it is to find all the foxes but exceed the time limit.

Regular practice is the most important activity you can do to develop your individual best strategies, map and compass skills, and radio listening skills.

References

Radio Orienteering - The ARDF Handbook, Titterington, Williams, & Deane. RSGB, also available from ARRL

Transmitter Hunting - Radio Direction Finding Simplified, Joseph D. Moell, K0OV, & Thomas N. Curlee, WB6UZZ. TAB Books

Region II ARDF web site, <http://www.ardf-r2.org>

Radio Amateurs of Canada ARDF web site, <http://www.rac.ca/opsinfo/ardf.htm>

BC area ARDF announcements, <http://bcradiosport.qclubb.com/public>

Sweden ARDF site for some online ARDF games, http://www.pejla.se/ardf_games.htm

Joe Moell's web site, <http://www.homingin.com>