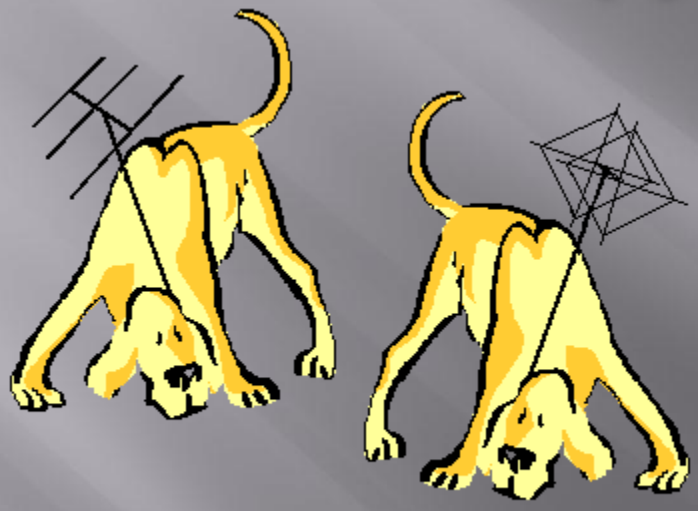
RADIO DIRECTION FINDING FUNDAMENTALS PART 1



Ron Milione, Ph.D.

W2TAP

Why do we need these skills?

- Locating Harmful Interference
  - Jammers
  - Stuck transmitters
  - Local noise sources
  - Interference
- Search and Rescue
  - ELT/EPIRBs
  - FRS/ham radios
  - Wildlife location

Background Info…..

Radio direction finding or RDF has been around since before World War One. From the time of the invention of radio, there has been a desire to know from what direction a radio signal was arriving at the listener's radio receiver.

Amateur Radio has found several uses for RDF:

• Hunting down interfering radio signals, both accidental and malicious interference to repeaters (affecting both ham and commercial communications, including emergency services).

• Helping to locate downed aircraft by DFing their emergency locator beacons (ELT).

• The entertaining sport of "fox", "bunny" or T-hunting.

Background Info…..

It is "fox hunting" that has spread through many ham radio clubs around the world as a very exciting and fun aspect of the hobby. Fox hunting can take many forms of transmitter hunting, from a person hiding within a few blocks of the starting point with his handheld and periodically making a transmission while others try to find him on foot using directional antennas; to a competition with multiple unmanned automatic transmitters scattered over a course that can be several hundred kilometers long – the entrants being required to find each transmitter in proper order with a minimum number of kilometers driven. Another variation includes jogging or running from one low power fox transmitter to another while carrying RDF equipment.

Background Info…..

What makes fox hunting so popular?

- The social aspect of getting together with others with similar interests.
- Anyone can take part - you don't need a ham license since only a receiver is required.
- The satisfaction of building your own equipment such as an antenna for use in RDFing.
- The fun and competitiveness of the hunt, which also can involve both physical and mental exercise (walking while searching, and the calculations and map plotting required to determine where the fox may be located).
- The outdoor aspect of the sport (sunshine and fresh air).

Background Info…..

The "fox" has several basic requirements:

• Be able to move to a location unobserved by those who plan on taking part in the hunt.
• Be able to hide well enough at the location he has chosen so he will not be accidentally spotted. The hunters should have to almost stumble over him in order to find him.
• Be equipped with enough handheld battery capacity, water, lunch etc. for the expected duration of the hunt - it could be one or two hours or more in length, depending on the distance the fox is from the starting point and how well he is able to confuse the hunters as to his probable location.

An unmanned, automatic fox transmitter is the better choice since it can be hidden hours or even a day before the hunt and can be turned on remotely via a sequence of touch tones.

Background Info…..

The "hunter" needs several things to make it possible for him to find the fox.

- A 2 meter portable receiver with some sort of signal strength indicator.
- A portable antenna with directional characteristics so that the signal peak or null can be used to determine the direction to the fox.
- A means to attenuate or reduce the signal strength from the fox transmitter so that it will remain near the halfway point on the receiver's signal strength indicator. As you get nearer to the fox transmitter, the signal will keep getting stronger - it will have to be attenuated to enable you to be able to locate a signal peak or null.

A fox frequency of 146.565 MHz in the 2 meter ham band is most popular in Canada and the U.S., although any open simplex frequency could be used.

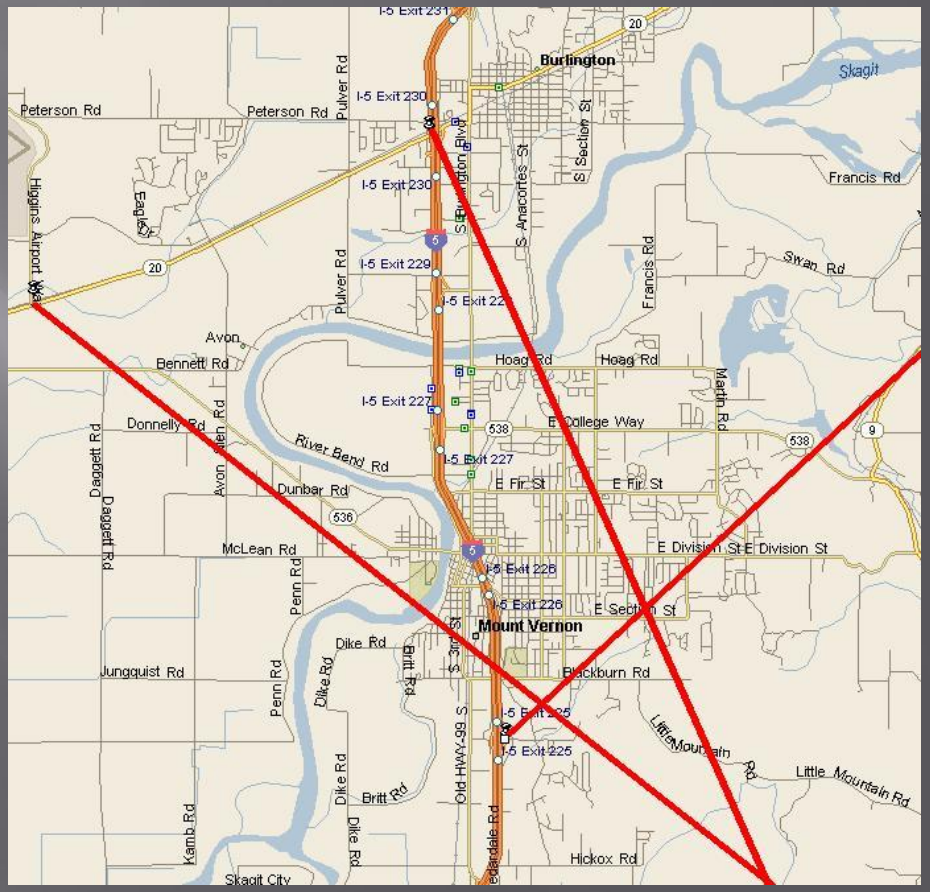
Background Info…..

Any 2 meter handheld transceiver can be used, or a portable scanner covering the 2M band. During the mobile part of the hunt when you are driving toward the probable location of the fox, a mobile 2M rig could be used, but eventually you are going to have to get out of the car and complete the final stage of the hunt on foot – so a portable receiver is a requirement. Some of the best antennas for fox hunting are homemade ones such as the quad and yagi designs included here. There are many other types of RDF antennas such as the loop or ZL special in addition to many electronically augmented designs such as the TDOA (time difference of arrival) and switched antenna system.

Occasionally you can find a bargain at a flea market on a suitable RF attenuator for use on 2M. It can be either a switched type or a slider type like the design included here, but in order to be useful for RDF and fox hunts, it should be capable of 60 to 100 dB of attenuation (of course 2 attenuators can be connected in series to obtain this value). Just remember that you cannot transmit through an attenuator without damaging either it or your transmitter.

Triangulation

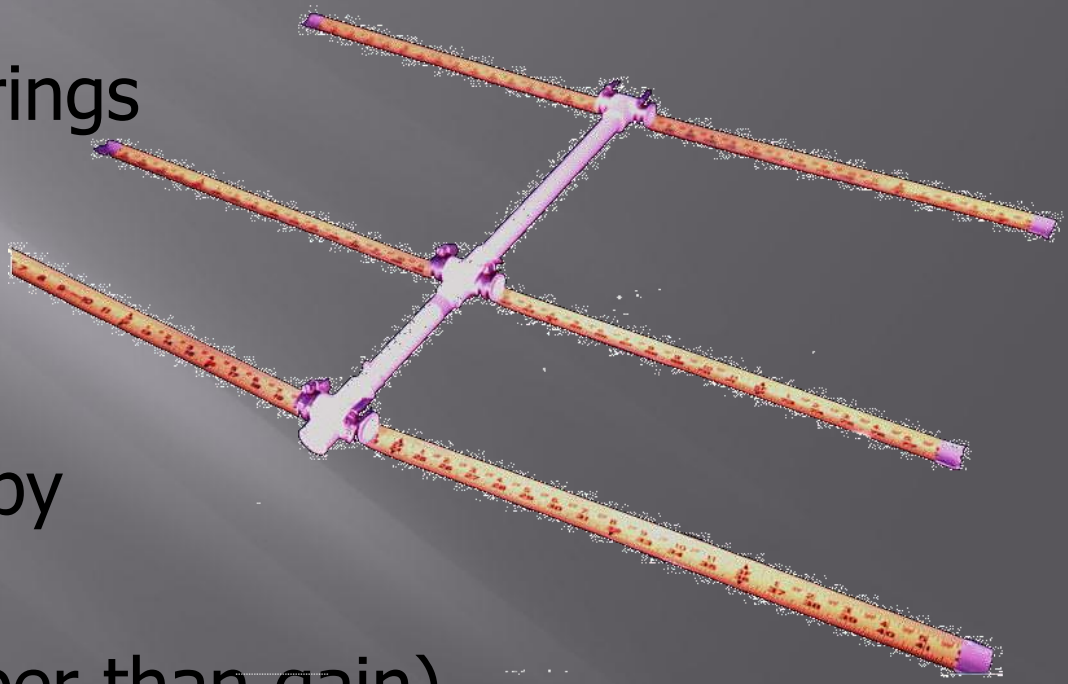
- Theory
  - Take bearings from three points
  - 90% of contacts will be inside intersecting triangle
- Don’t neglect signal strength info
- Signal strength will depend on terrain



Wire Antenna

- Simple
- Signal strength only
- Directivity via body blocking
- Works better with stronger signal and well shielded receiver
- High skill level required

Beam/Yagi



- Very accurate bearings
- Requires clean pattern and good front-to-back ratio
- Easily overloaded by strong signals
- Tune to null (sharper than gain)
- Can use front to help find weaker signals but with reduced bearing accuracy

Loops

- More common on HF frequencies
- Very compact
- Tune to the null
- Bearings not very precise
- Has 180 degree ambiguity

Adcock Device – Handi Finder

- Based on phase difference
- Antenna array MUST be symmetric
- Can't identify front/back without a third sense antenna
- Tune to no tone (signals in phase)
- Weak signals can be a problem
- Strong signals may cause too much multipath

“Doppler” DF – DF Jr.

- Not real Doppler – uses a pair of Adcock antennas
- Gives real-time bearings
- Only accurate to ~30 degrees
- Antenna size and spacing are frequency dependant

“Doppler” DF2020T

“Doppler” DF2020T

FUNCTIONS…….

Multi Display – Numeric & 36 LED pelorus display
Compatible with APRS software

Can use with “**Navi2020”** map plotting display program (with the optional GPS Receiver) Uses GoogleEarth™ viewer for displaying map of ploiting.

Automatic or manual operation

Accepts standard $GPRMC NMEA GPS message

Archive Navi files are auto-saved

“Doppler” DF2020T

SPECIFICATIONS

Microcomputer / DSP Doppler DF
DF Antenna Module with built-in magnetics on the bottoms for easy install

GPS input for "moving map" Windows display
RS232 output for PCs (can use with Serial to USB conveter)
Uses **Any Type of FM Receiver and Scanner, Wideband Antenna** design
12 - 28 VDC operation
Pre-assembled External Antenna Unit for Plug and Play
4 antenna elements and new circuit design for improving the sensitivity and accuracy

Suitable from 100 to 1000 Mhz and beyond
Useful from 88 to 100 MHz with reduced sensitivity

“Doppler” DF2020T

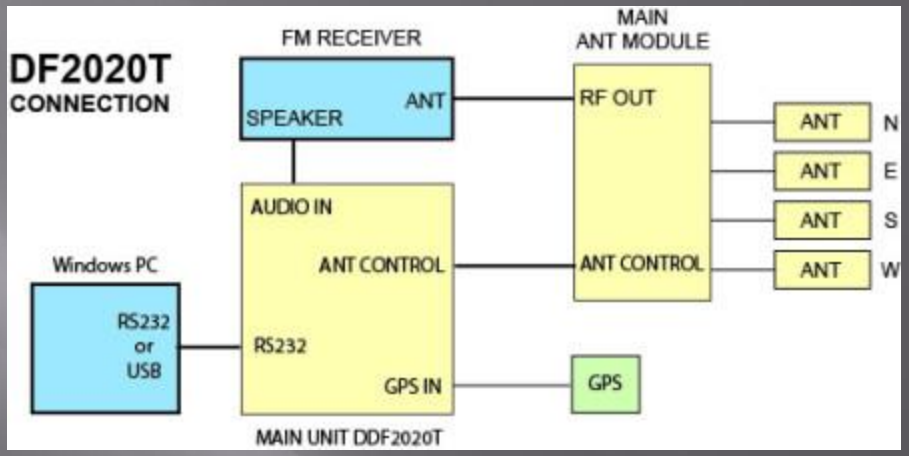
MAJOR FEATURES

VHF/UHF Doppler type DF, (4 antennas) primarily for mobile DF operation, 100 to 1000 MHz

The user must provide additional equipment (PC or laptop) to use the

DDF2020T DF System:
A VHF/UHF FM receiver is required. (For receiving a signal for DF)
Pre-assembled antenna unit for Plug and Play

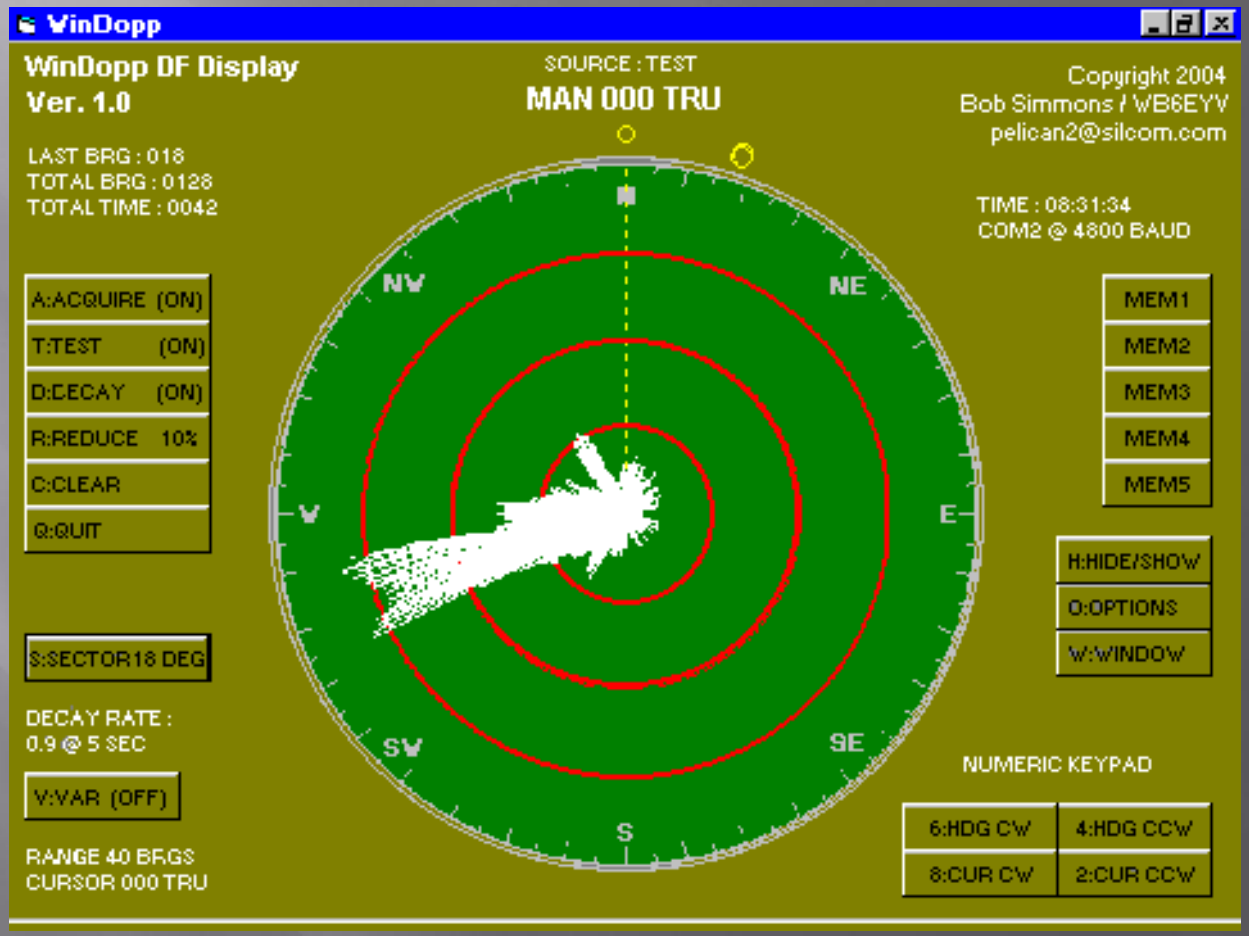
“Doppler” DF2020T



DDF2020T Connection Diagram

When you use RS232(Serial) To USB Convertor, please install the right driver comes with it.
Antenna N should be placed in frontward of vehicle to indicate 0 degree of DF.Display**.**
When DDF2020 tunes with the right RF signal, it outputs clear 430 Hz audio signal which will indicates stable LED.

“Software”


VinDopp
WinDopp DF Display
Ver. 1.0
SOURCE : TEST
MAN 000 TRU
Copyright 2004
Bob Simmons / WB6EYV
pelican2@silcom.com
LAST BRG : 018
TOTAL BRG : 0128
TOTAL TIME : 0042
TIME : 08:31:34
COM2 @ 4800 BAUD
A:ACQUIRE (ON)
T:TEST (ON)
D:DECAY (ON)
R:REDUCE 10%
C:CLEAR
Q:QUIT
MEM1
MEM2
MEM3
MEM4
MEM5
H:HIDE/SHOW
O:OPTIONS
W:WINDOW
S:SECTOR18 DEG
DECAY RATE :
0.9 @ 5 SEC
V:VAR (OFF)
RANGE 40 BRGS
CURSOR 000 TRU
NUMERIC KEYPAD
6:HDG CW
4:HDG CCW
8:CUR CW
2:CUR CCW
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SE
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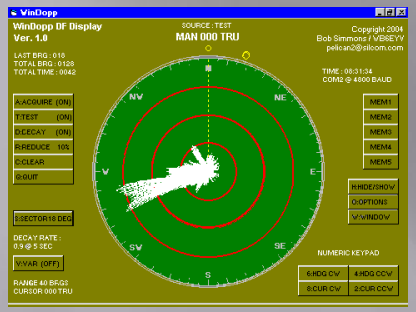


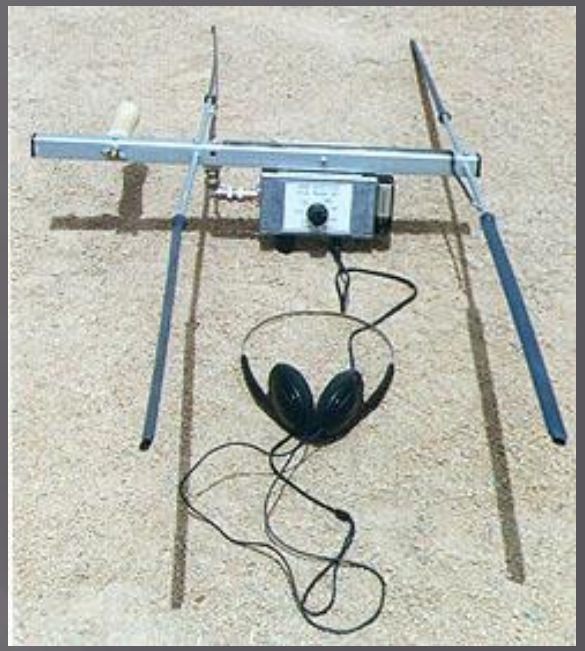
"Software"

The **WinDopp** PC / Windows display program is a Windows display program for most DF's. It has a simulation mode that allows it to be used without a DF input... For testing and getting familiar with. If a GPS receiver is provided, the **WinDopp** program uses the GPS heading to stabilize the azimuth display, which fully enables the signal integration features of the program.

WinDopp uses an RS232 COM port 1 - 8 (or USB port with user-provided adapter) and selectable baud rates, 1200 to 9600. Standard Agrello DF message allows use with other DF units. User defined color scheme and COM settings are saved on exit, selectable GPS or manual heading inputs. Includes 3 quasi-DSP features to enhance the display and assist identification of signal direction.

Foxhunting

- Containment Area
  - Large (county) vs. small (city) or local (park)
  - Drive times become significant
- Starting location
  - Together vs. distributed
- Radios/antennas
  - HTs vs. mobiles
    - HTs offer portability but mobile meters are often more accurate
  - Omni vs. beam
    - Even 2m beams are unwieldy, omnis offer some info while driving



RDF Techniques

- Mapping
  - Time vs. accuracy
  - Accurate bearing plotting is time consuming but often valuable
- Terrain
  - Multipath issues – particularly in urban areas
  - Reflections can mislead and can be accentuated if the target uses a directional antenna

RDF Techniques

- Going the last mile
  - Attenuators for non-Adcock antennas
  - Removing the antenna when within a couple blocks
  - Body blocking
  - Detuning decreases receiver sensitivity
  - Tune a harmonic (2m 3rd harmonic on 70cm)
  - Be aware of local multipath sources

Resources

- Homing In Site

  http://www.homingin.com/

- Doppler System

  http://www.dopsys.com/

  Arrow Antenna

  http://www.arrowantennas.com/

- SWSSEC DF System

  http://www.swssec.com/tracknet.html

Thank you