

# *FOX HUNTING 101*

## INTRO TO RADIO DIRECTION FINDING



Clint Miller KØGR

# What is Fox Hunting?



# What is Fox Hunting?

- ▣ Locating a hidden transmitter by means of Radio Direction Finding (RDF)
- ▣ Also know as:
  - Hidden Transmitter Hunt
  - Bunny Chasing
  - T-hunting
- ▣ Locate the transmitter by taking several bearings and triangulate on a map
- ▣ Usually timed so speed matters
- ▣ No license needed – receive only

# Why Fox Hunt?

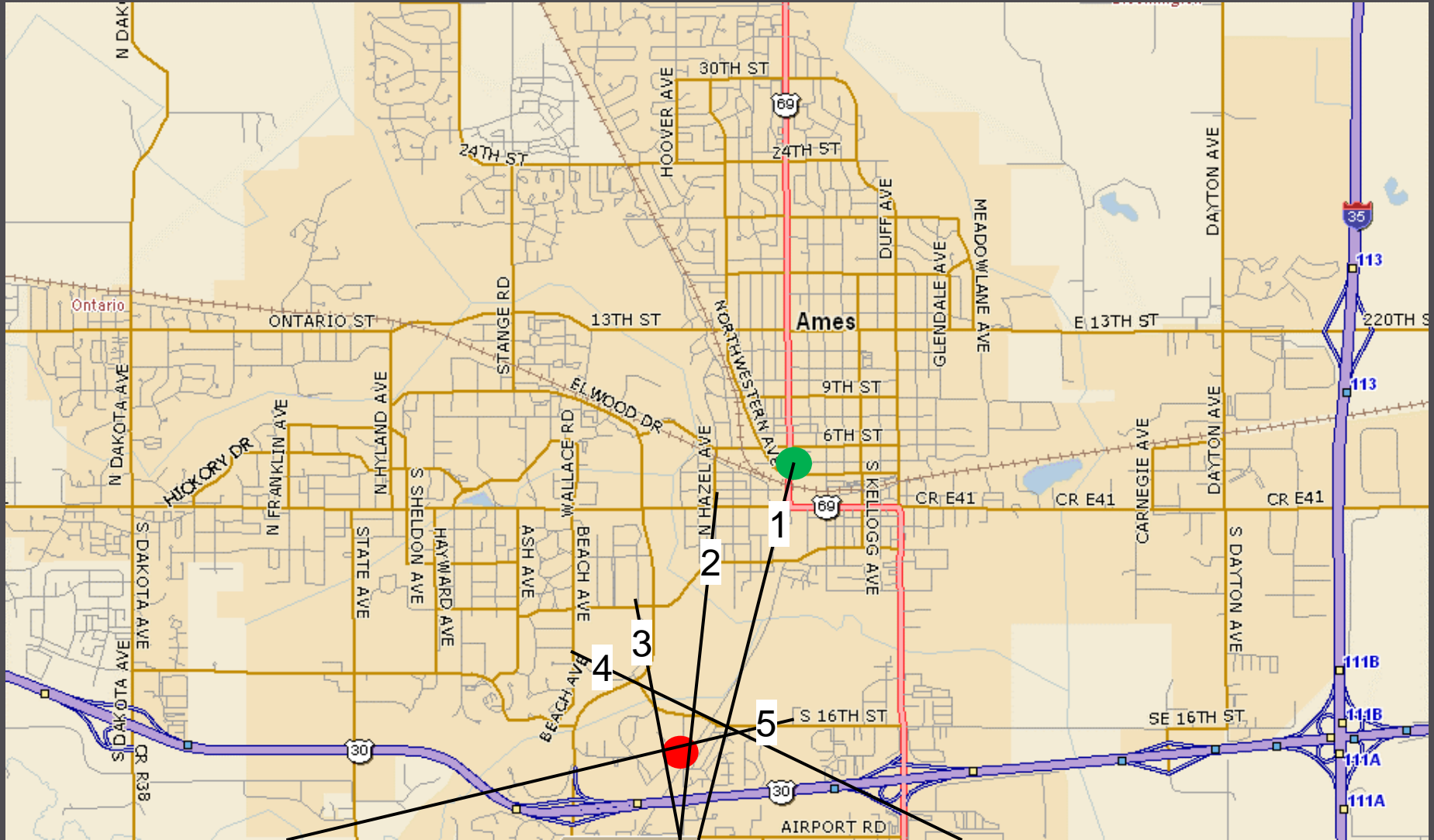
- ▣ Learn new skills
- ▣ Be prepared to find:
  - Sources of interference
  - Stuck transmitter
  - Persons in distress
  - ELT - Emergency Locator Transmitter for aircraft
- ▣ Excuse to build new equipment
- ▣ Competition and bragging rights
- ▣ Every hunt is a new mystery
- ▣ It's fun!



# Fox Basics

- ▣ Someone hides the 2 meter FM transmitter
  - Repeating tone or voice sequence
  - ON – OFF timing can vary
  - Sometimes the hider is the fox
- ▣ Hunters use directional antennas
  - Take direction readings from several locations
  - Triangulate the bearings
  - Home in and take more readings
- ▣ Hunt continues until everyone finds it or time runs out

# Foxhunt Basics



# Fox Hunting's Cousin: ARDF (Amateur Radio Direction Finding)

- ▣ International on-foot-only sport
- ▣ A map and compass exercise
- ▣ Participants start near one end and proceed to the other
- ▣ Plot bearings on detailed orienteering maps provided by organizers
- ▣ Successful hunters pay careful attention to:
  - Their own location
  - Bearings to all foxes at all times
  - Timing of transmitters





# ARDF

## (Amateur Radio Direction Finding)

- ▣ First ARDF World Championships in 1980
- ▣ A standard course:
  - Five "fox" transmitters on same frequency
  - 1 minute rotating schedule
  - Large wooded area of at least 500 acres
- ▣ CW transmitters sending "MO"
- ▣ Dits indicating the transmitter number
  - MOE, MOI, MOS, MOH, and MO5
- ▣ Punch a card at each fox







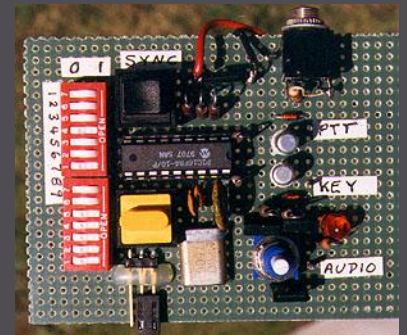
# Fox Boxes for 2 Meters

- ▣ Old School
  - Ham and transmitter
  - Read a book, club newsletter, QST
- ▣ Basic continuous
  - Transmitter (HT or Mobile)
  - MP3 player - loop message with ID
- ▣ Build-your-own
  - Transmitter (usually an old HT)
  - Microcontroller / timer unit / MP3 player and VOX
  - Battery
- ▣ All-in-one



# Build-Your-Own Radio Controller Kits

- ▣ Un-Music Box
  - Designed by KØOV
  - Easy-to-build project
  - Common CMOS IC's
- ▣ TBOX
  - Designed by Ron Seese N6MBR
  - 80C51 microprocessor
- ▣ Montreal Fox Controller
  - Designed by Francois Tremblay VE2JX  
and Jacques Brodeur VE2EMM
  - 16F84 reprogrammable PIC





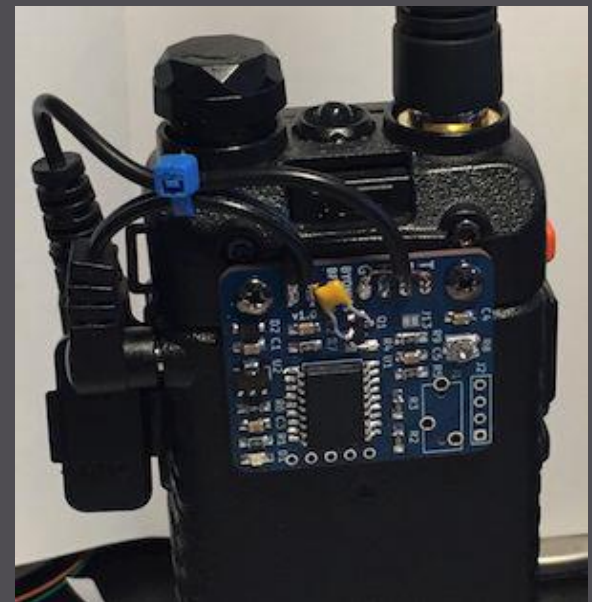
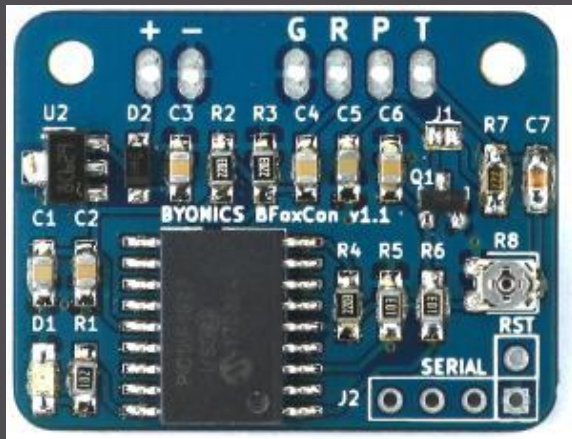
# Build-Your-Own Byonics PIC Microcontroller Based Radio Controllers

- ▣ PicCon
  - With case ~~\$42 kit~~ / \$69 built and tested
  - Field programmable via DTMF tones
  - Version 3 also PC programmable



# Build-Your-Own Byonics PIC Microcontroller Based Radio Controllers

- ▣ BFoxCon Baofeng Foxhunt Controller
  - Mounts on inexpensive Baofeng UV-5R
  - Powered from HT battery
  - ~~\$45 kit / \$63 built & tested~~



# All-In-One Transmitters

## Byonics MicroFox Transmitters

- ▣ MicroFox 50
  - Adjustable .05mW to 50mW
  - LiPo battery
  - 144MHz - 148MHz
  - \$100





# All-In-One Transmitters

## Byonics MicroFox Transmitters

- ▣ MicroFox2
  - 500mW transceiver
  - Similar function to MicroFox PicCon
  - LiPo battery inside a small, rectangular tube
  - 144MHz - 148MHz
  - 5 hours at ½ duty cycle
  - DTMF tones programmable
  - \$149



# All-In-One Transmitters

## Byonics MicroFox Transmitters

- ▣ MicroFox PicCon
  - 700mW transceiver
  - PicCon Fox Controller
  - 144MHz - 148MHz
  - 3 AA batteries
  - 20 hours at ½ duty cycle
  - DTMF tones programmable
  - \$126



# Basic Hunting Equipment

- ▣ Receiver
  - Handheld Scanner
  - HT
- ▣ Antenna
  - Rubber ducky (body block method)
  - Loop
  - Dual antenna homing sets
  - Cubical quad
  - Yagi
  - Tape measure yagi
- ▣ Attenuator

# Start with your HT

- ▣ “Body block” or “body shield” technique most basic
- ▣ Open Squelch 100%, you want to hear noise!
- ▣ Hold HT tight against your chest
- ▣ Turn around slowly, looking for the direction at which your body blocks signal most effectively (signal null)
- ▣ Signal is coming from directly behind you
- ▣ Walk in the direction of null, taking bearings at regular intervals
- ▣ Observe as signal strength get stronger

# Start with your HT

- ▣ When signal is so strong that you can't find the null, tune 5 or 10 KHz off frequency
  - Puts signal into receiver's IF passband edges
  - Equivalent of 40 to 60 dB attenuation
- ▣ Dual-band (144/440 MHz) HT or scanner hunting on two meters
  - Tune much weaker third harmonic of signal in 70 cm band while performing "body shield"
- ▣ Disconnecting "rubber duck" antenna will knock down signal even more
  - Hearing signal with antenna off is usually a "You are here!" or "Hot / Cold" indicator

# Start with your HT

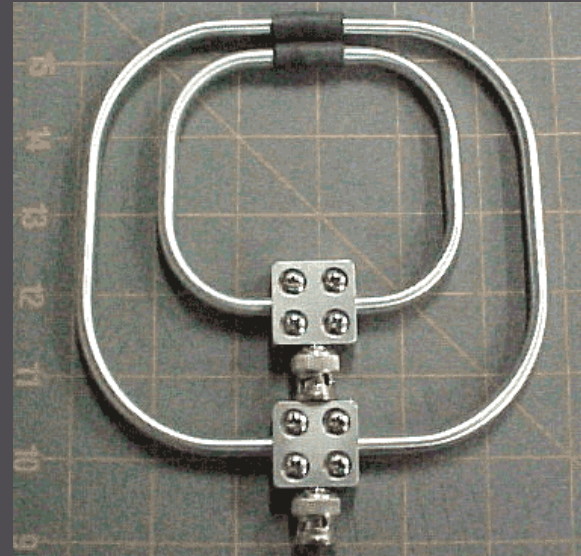
- ▣ Some hunters wrap aluminum foil around their HTs to attenuate signal even more
  - Be sure to put insulating tape over battery charging terminals on bottom first
  - Foil might damage radio by shorting terminals
- ▣ “Body block” null is rather shallow
  - Can be filled in by signal reflections (multipath), nearby objects, etc.
- ▣ When using this method, stay away from large buildings, chain-link fences, metal signs
  - If you do not get a good null, move to a clearer location and try again



# Receiving Loop Antennas

- ▣ Receiving loop is used to listen for null broadside to antenna (minimum signal)
- ▣ Can provide a very sharp bearing, readable to plus or minus 5 degrees
- ▣ Has advantage of being less affected by reflection signals due to its Faraday shield
- ▣ Can be only antenna if signal is strong enough to be received by untuned loop
- ▣ If signal is too weak, a Yagi is recommended for its directional gain
- ▣ If too strong, attenuator may be required

# Receiving Loop Antennas



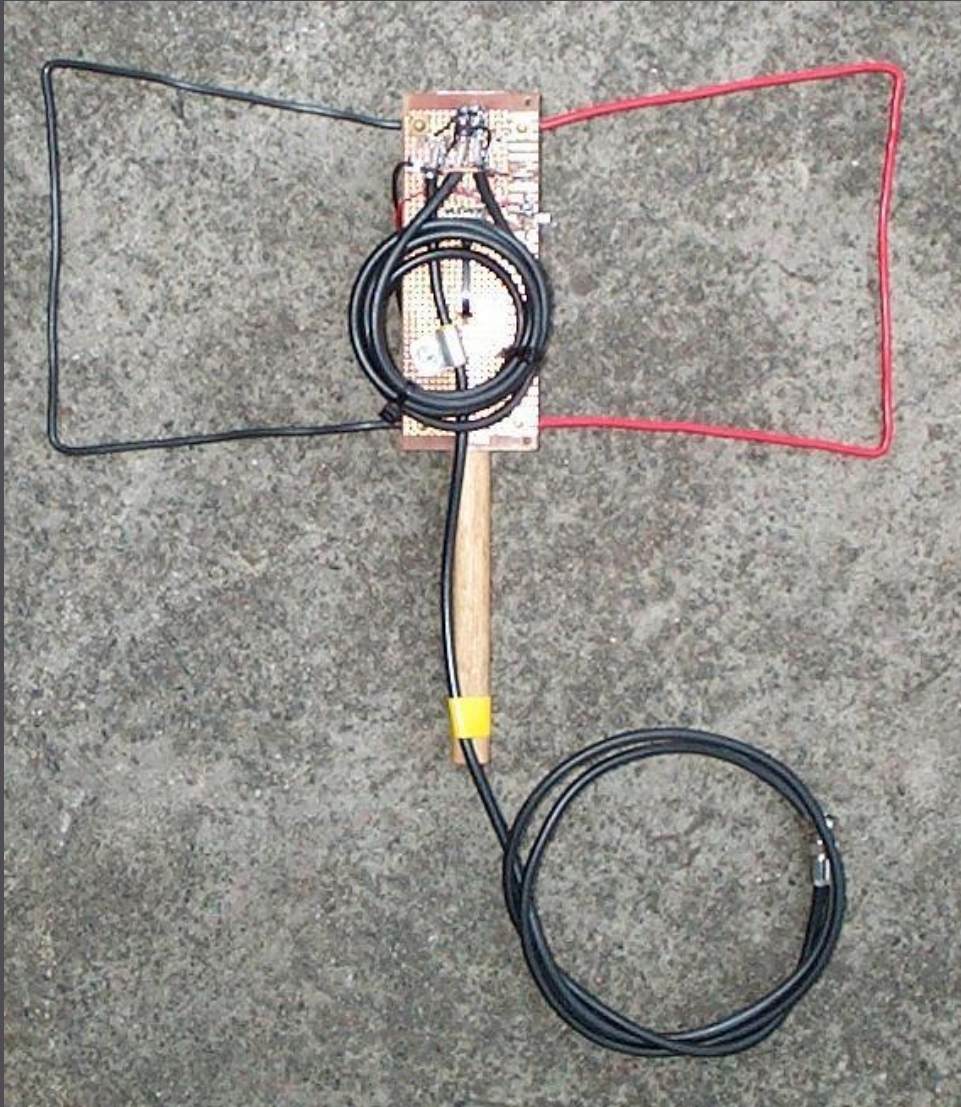
- ▣ Arrow Antennas VHF Fox Hunt Loop \$79
- ▣ BNC mounts directly on HT or 4 MHz offset attenuator

# FM-based Dual-Antenna Sets

- ▣ Time-Difference-Of-Arrival (TDOA) principle
- ▣ Simple and easy to build
- ▣ Work with any 2m FM mobile or handheld
- ▣ Many different designs of TDOA units
- ▣ Some have additional "bells and whistles"
- ▣ Consists of a small dual antenna array and an electronic antenna-switching unit
- ▣ Two vertical dipole antennas
  - Separated 12 to 36 inches apart
- ▣ Sometimes use a "bowtie" antenna
- ▣ Mounted on a T-shaped support for rotation



# HANDI-Finder

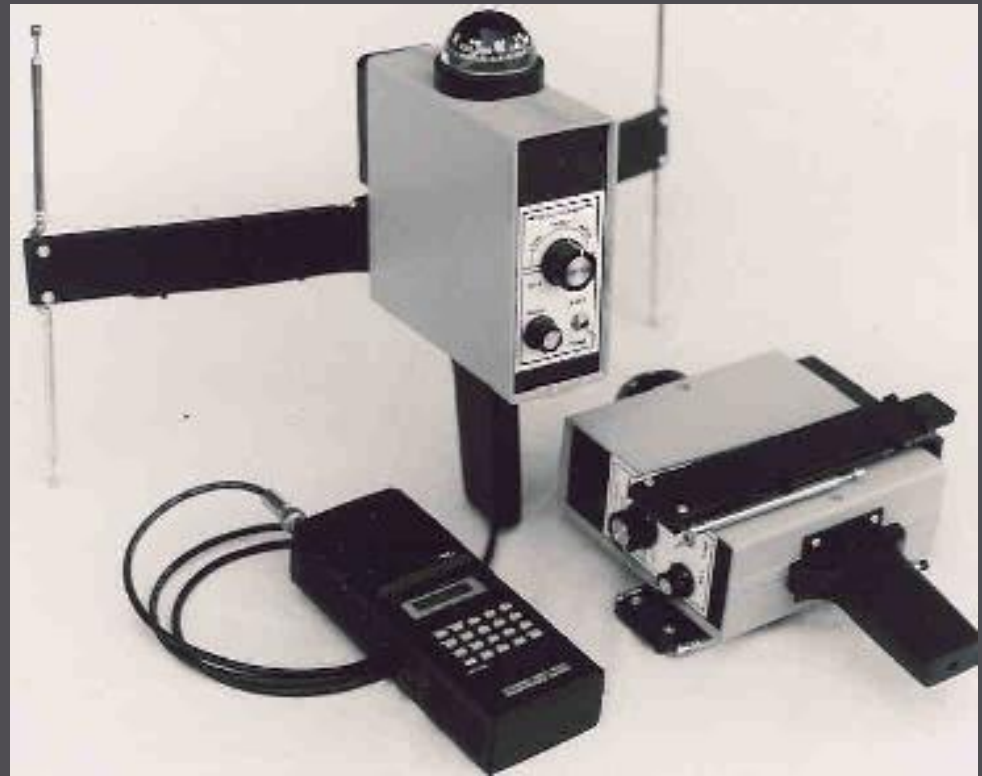


\$29.95

[www.noard.com](http://www.noard.com)

# FM-based Dual-Antenna Sets

- ▣ Vector-Finder by National RF, Incorporated
  - Operate on the phase shift technique
  - Starts at \$239.95



# Directional Antennas

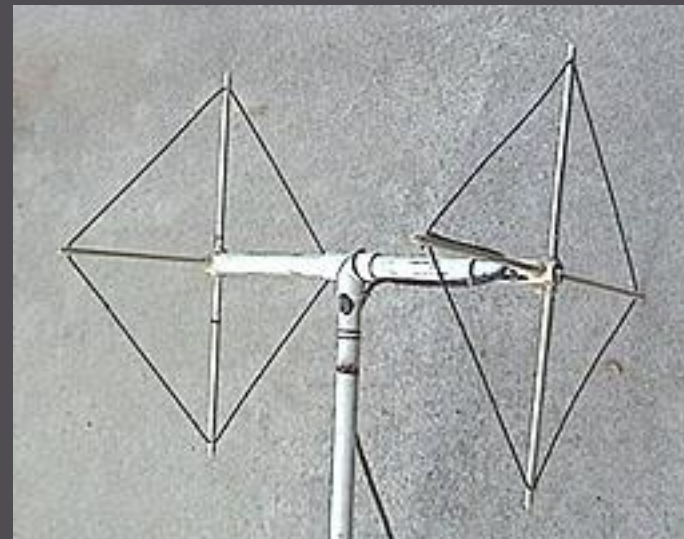
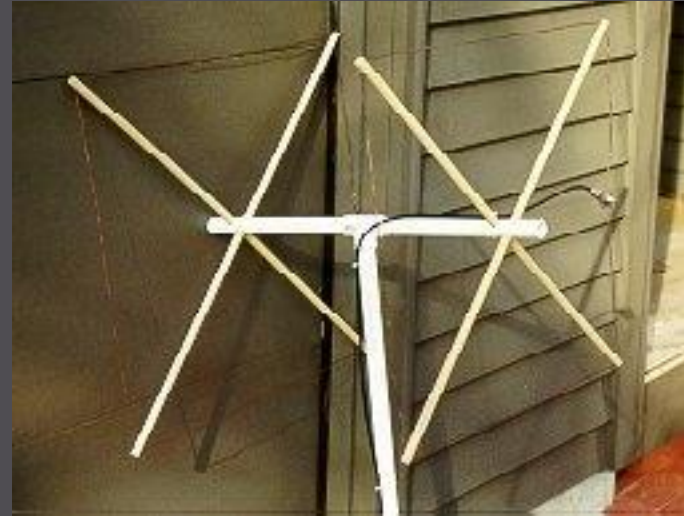
- ▣ You'll get much more accurate bearings, plus more sensitivity when hunting weak signals, if you use an antenna with forward gain and directivity
  - Cubical quad
  - Yagi
- ▣ Point antenna toward the horizon and turn in a 360-degree circle to find direction in which signal is strongest
  - Locating nulls on your left and right is sometimes more effective



# Directional Antennas

- ▣ When signal strength is greatest, high-gain antenna is "pointing" toward signal source
- ▣ You could remove and carry 4-element yagi or quad normally used mobile
  - Large and cumbersome
- ▣ You don't need that much gain and pattern sharpness
  - Two or three elements will do nicely
- ▣ A small UHF yagi or quad will give sharp bearings on third harmonic when you are within a few dozen feet

# Cubical Quad Antennas



# Cubical Quad Antennas

- ▣ More compact than a yagi or phased array
- ▣ Safer because it does not have long pointed elements
- ▣ Better pattern than yagi for vehicle mounted
- ▣ Somewhat tricky to tune and has a narrow bandwidth (about 500 KHz)
- ▣ Excellent choice if most of your hunts are on one frequency and mobile compatible

# Cubex Quad

- ▣ The Butterfly
  - 2 element, \$85
  - 7+ dbi gain at 145 MHz
  - F/B > 21dB
  - 16" boom
  - 21" Turn Radius



- ▣ Yellow Jacket
  - 4 element, \$125
  - 9+ dbi gain
  - Elements 21"
  - Boom 42" long





# DIY 3 Element Yagi

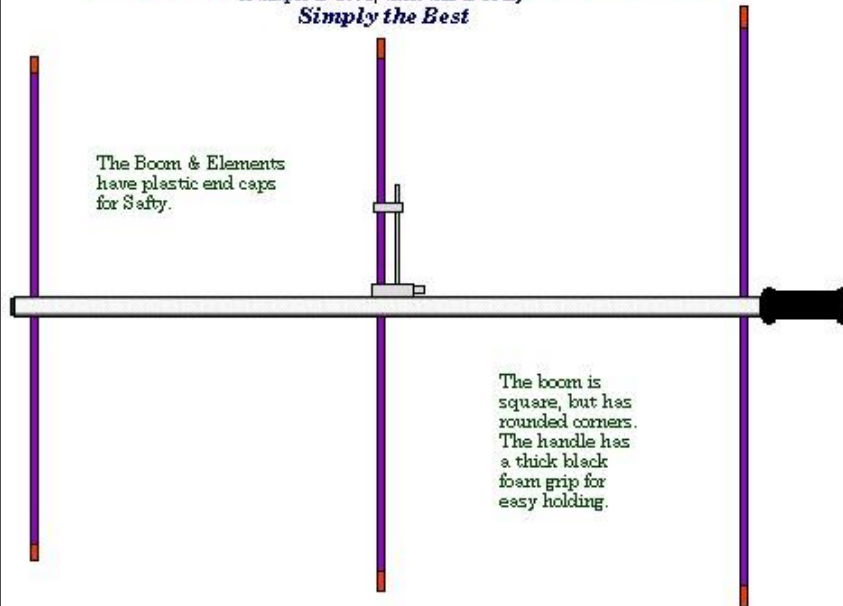




# Arrow II Portable Yagi

## Arrow II Hand Held Portable

If Simple is Good, then this is Truly  
*Simply the Best*



The Boom & Elements  
have plastic end caps  
for Safty.

The boom is  
square, but has  
rounded corners.  
The handle has  
a thick black  
foam grip for  
easy holding.

### Assembly Instructions

Attach the elements to the boom, by screwing the elements together through the boom. Attach feed line to the BNC connector. That's it. The Antenna is pre-tuned and ready to go.

### SPECIFICATIONS

No. Elements 3  
Element spacing is .2 wavelength.  
SWR 1.2:1  
Maximum Power (because the antenna is  
hand held power should be kept to <20 Watts)  
Boom 3/4" Sq. (T6061 Aluminum)  
Elements, Easton Aluminum Arrow Shafts  
Gamma Match, Is attached to half of the  
driven element (comes pre-tuned).  
Connector, BNC Only

**Model**  
**146-3**

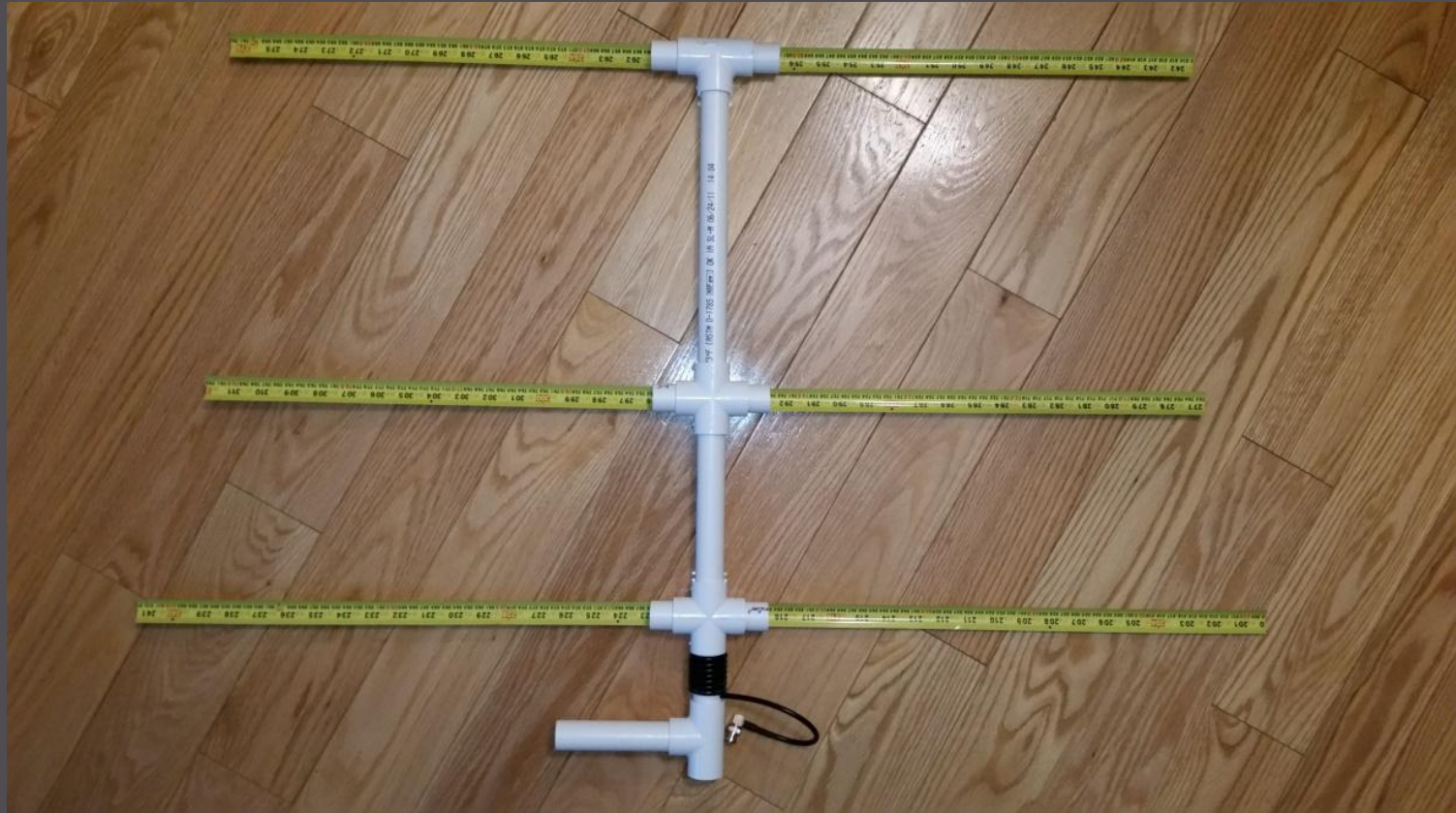
15 oz.



\$114

# Tape Measure Yagi

## Joe Leggio WB2HOL



# Tape Measure Yagi

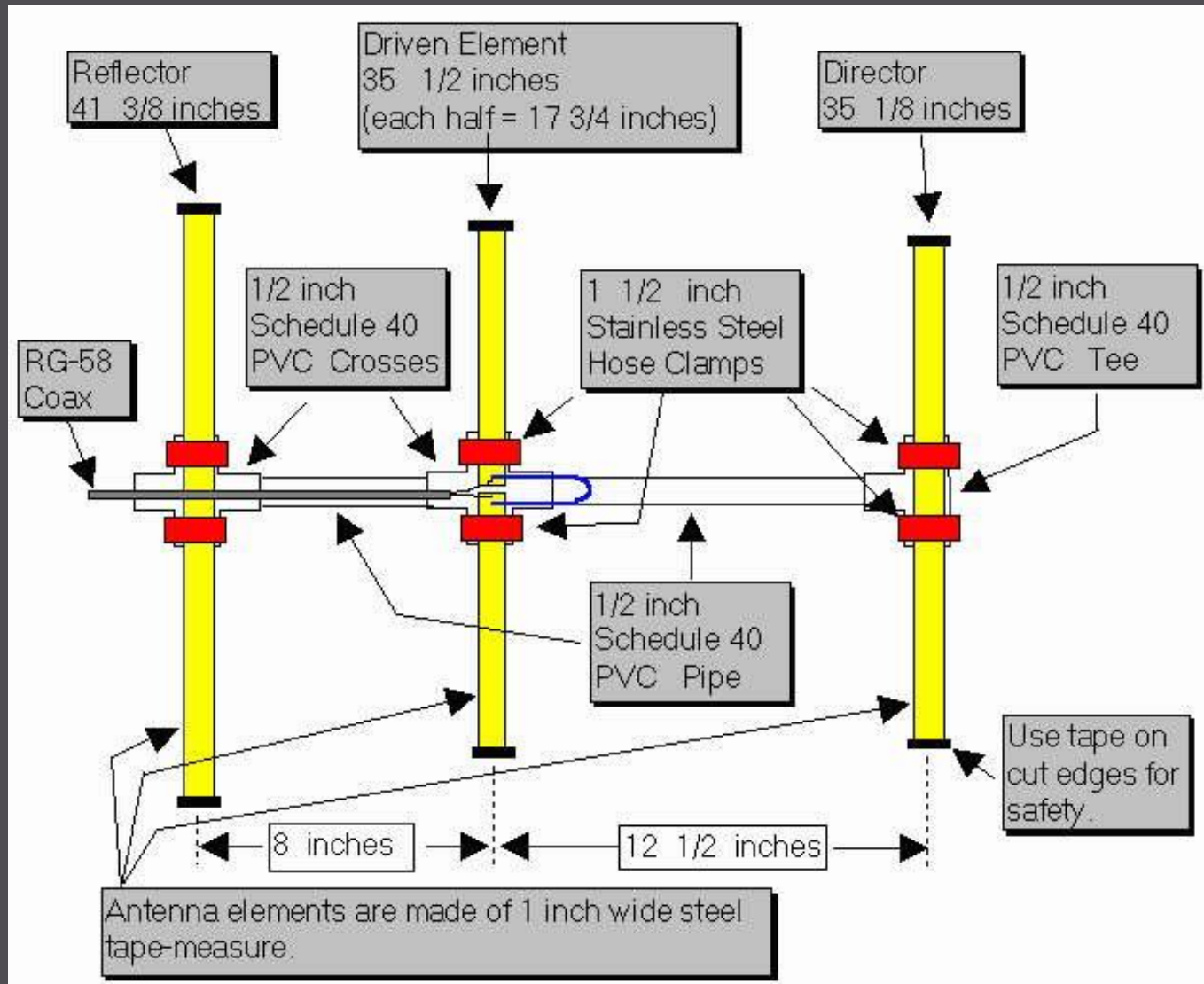
- ▣ Favorite two-meter radio-orienteeing antenna is the 3-element tape measure yagi
  - Original design by WB2HOL
  - [http://theleggios.net/wb2hol/projects/rdf/tape\\_bm.htm](http://theleggios.net/wb2hol/projects/rdf/tape_bm.htm)
- ▣ It's a simple project made from:
  - Steel measuring tape
  - PVC pipe and fittings
  - Hose clamps
  - Wire "Hairpin" match
- ▣ Three elements to keep the boom from getting too long

# Tape Measure Yagi

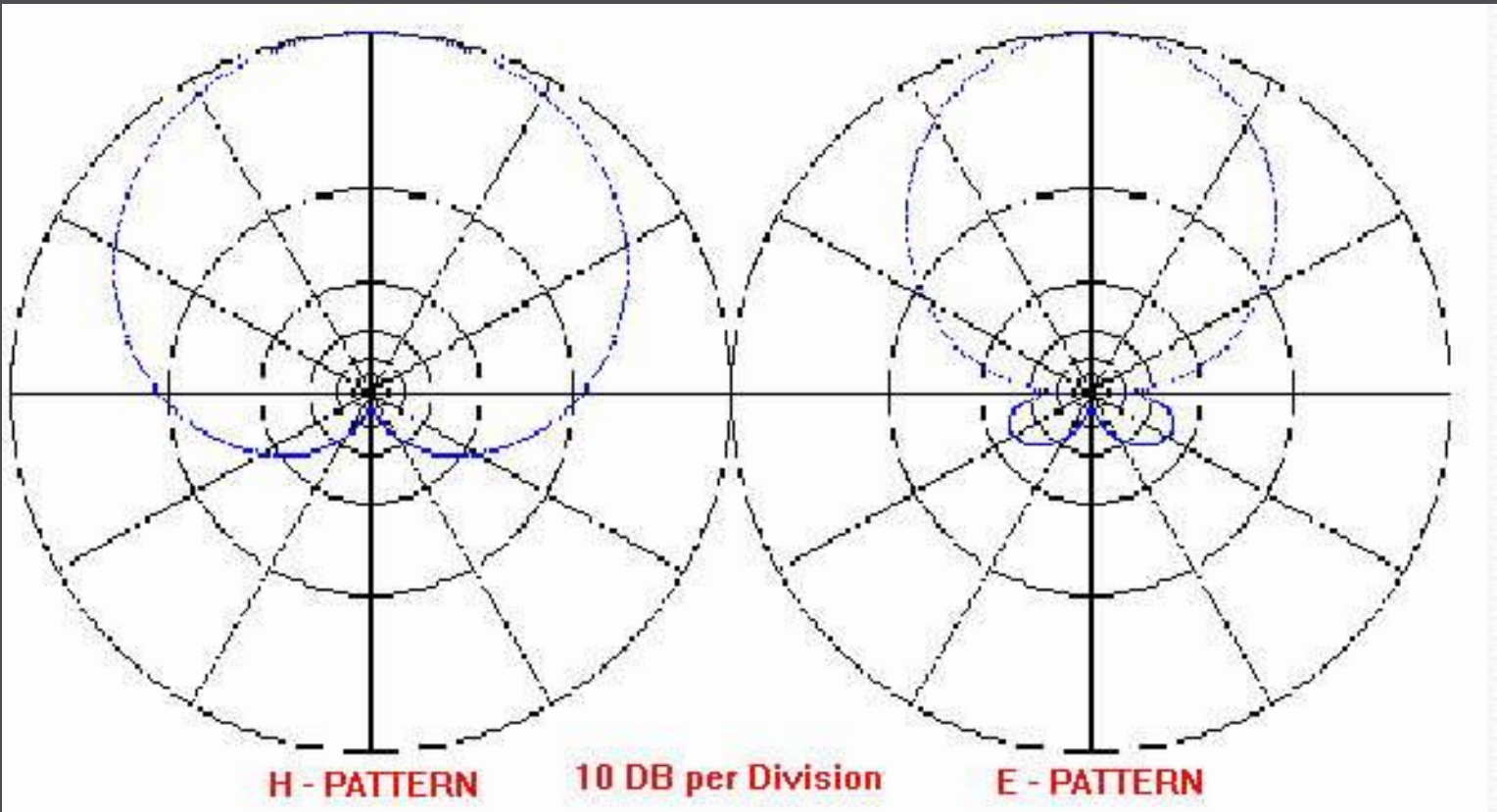
- ▣ Really great front-to-back ratio trades a bit of forward gain in exchange for a very deep notch in pattern toward rear
- ▣ Tape measure elements are self supporting yet fold if moving through brush or loading into a car
- ▣ Build this antenna from scratch using parts from your local hardware store



# Tape Measure Yagi



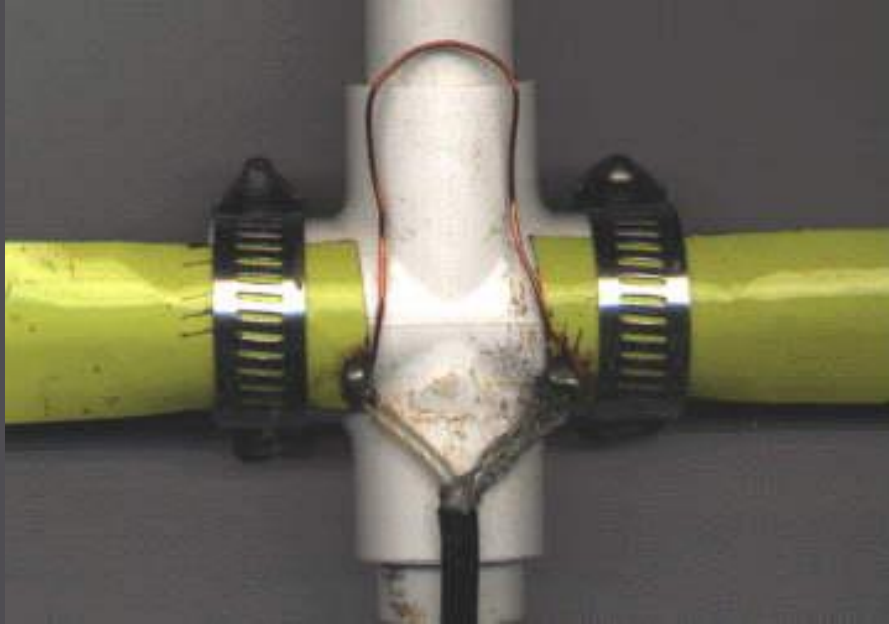
# Tape Measure Yagi



# Tape Measure Yagi

- ▣ Feedline signal pickup can make bearings unreliable (moves maximum lobe off-axis)
- ▣ Recommend adding a "choke" balun to minimize RF current on exterior of feedline
  - Not shown on the plans for WB2HOL Tape Measure Beam
- ▣ Wrap about 6 - 8 turns of coax around boom behind reflector
  - It will not work as well if you put balun between driven element and reflector

# Element Connection Options

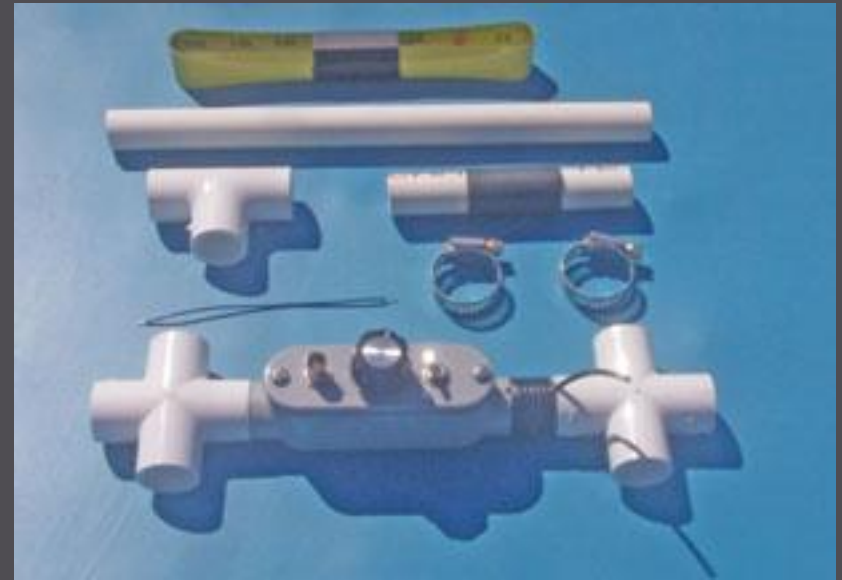
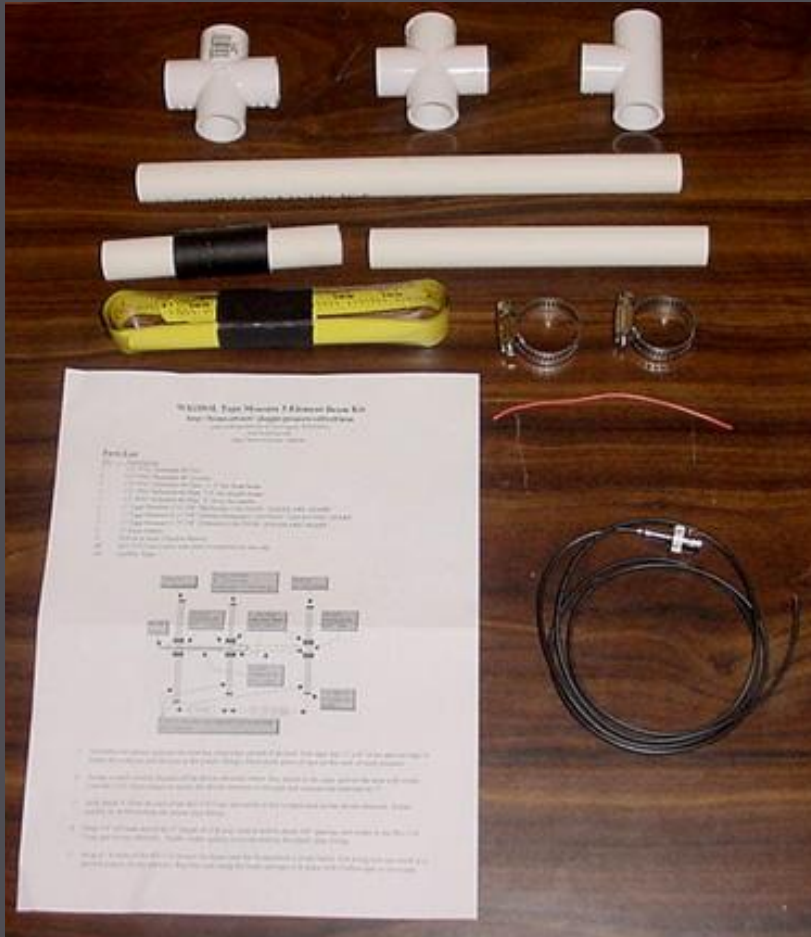


- ❑ Tape measure does not solder easily & PVC supports are easily melted
- ❑ Tin tape measure elements before mounting to PVC cross





# WB2HOL Kits



Currently no kits available online



# K0GR and W0YR “Tape Measure” Yagi Antenna Workshop Files

- ▣ [kb7vml.net/downloads](http://kb7vml.net/downloads)
- ▣ “Tape Measure” Yagi antenna assembly photos (PDF)
- ▣ Antenna Assembly Instructions (PDF)

Steps 13, 14, and 15



# 3D Printed Parts



# Attenuation:

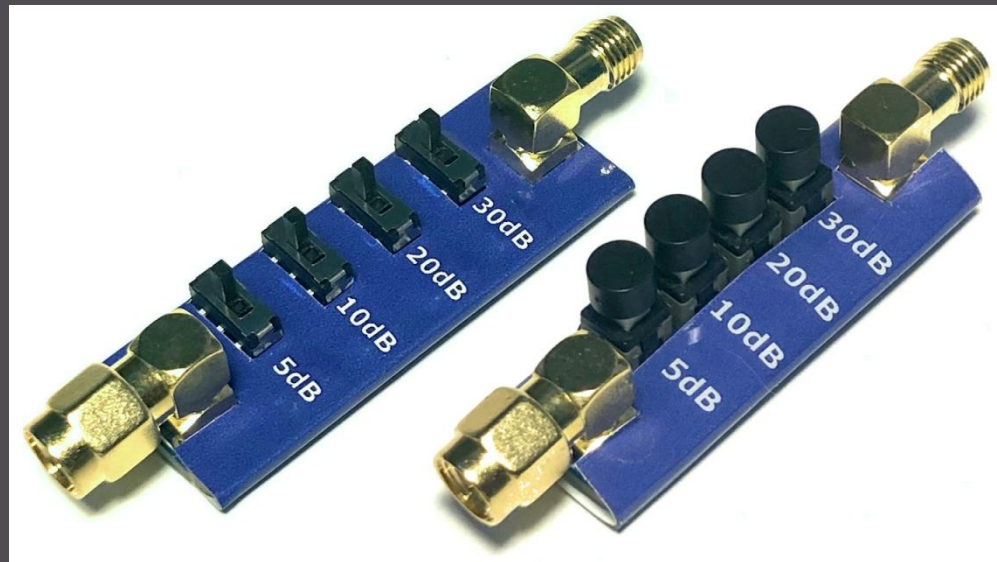
## The Successful Finder's Best Friend

- ▣ Use radio's S-meter to take bearings with your antenna at start
- ▣ When you get so close that S-meter goes off scale, you will need to reduce (attenuate) signal into receiver
- ▣ Rotating antenna polarization 90 degrees will attenuate signal 30 dB
- ▣ Tune 5 or 10 kHz off frequency 40 to 60 dB
- ▣ Third harmonic of signal 60 to 80 dB
- ▣ Disconnect the antenna



# Passive Step Attenuator Byonics

- ▣ Step Switch Attenuator
  - 4 independently selectable attenuation stages
  - 5dB, 10dB, 20dB and 30dB
  - Attenuation between 0dB and 65dB
  - \$23



# Passive Step Attenuator

- ❑ Simple resistive RF attenuators that are commonly used for mobile hunting don't work up close
- ❑ Signal will bypass attenuator and go through receiver case by time you have put in a few attenuation steps (case leakage)
- ❑ To reduce direct pickup by receiver, you can try aluminum foil shielding

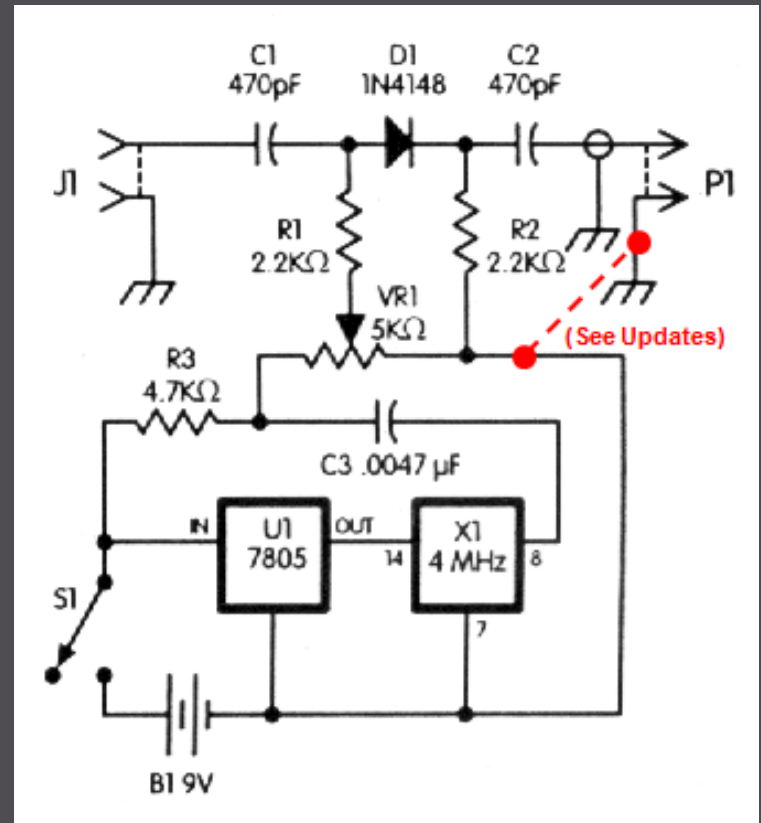


# Offset Attenuator

- ▣ A better way to get bearings on nearby foxes with HTs is to convert strong on-frequency signal into a weaker off-frequency signal
- ▣ Then you can tune your receiver to offset signal and measure its strength versus direction
- ▣ Other kinds of attenuators that are also called "active" so this is called "offset"

# Joe Moell KØOV Offset Attenuator

- ▣ Local oscillator connected to a diode mixer
- ▣ Shift receiver frequency 2 MHz or 4 MHz from transmitted frequency
- ▣ 20 dB to 100 dB or more attenuation



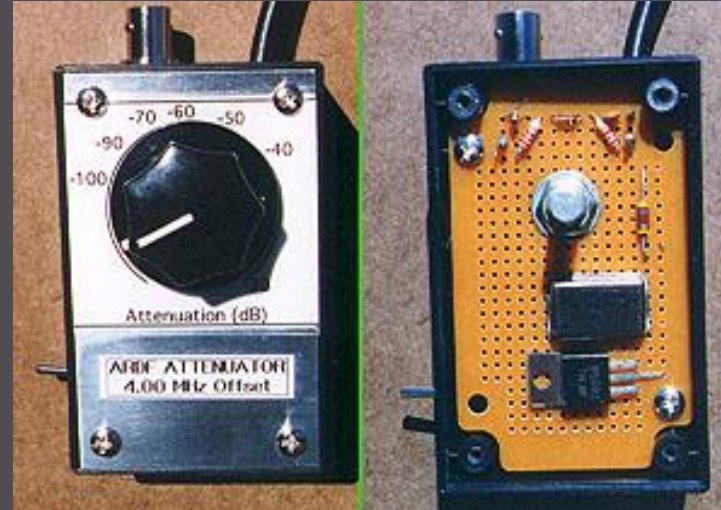
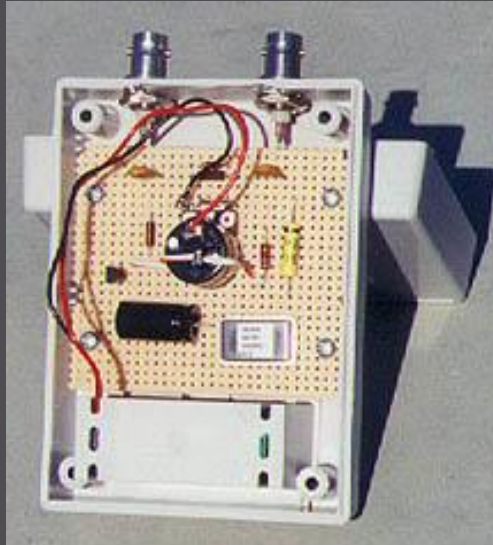


# Offset Attenuator Demo





# Joe Moell KØ0V Offset Attenuator



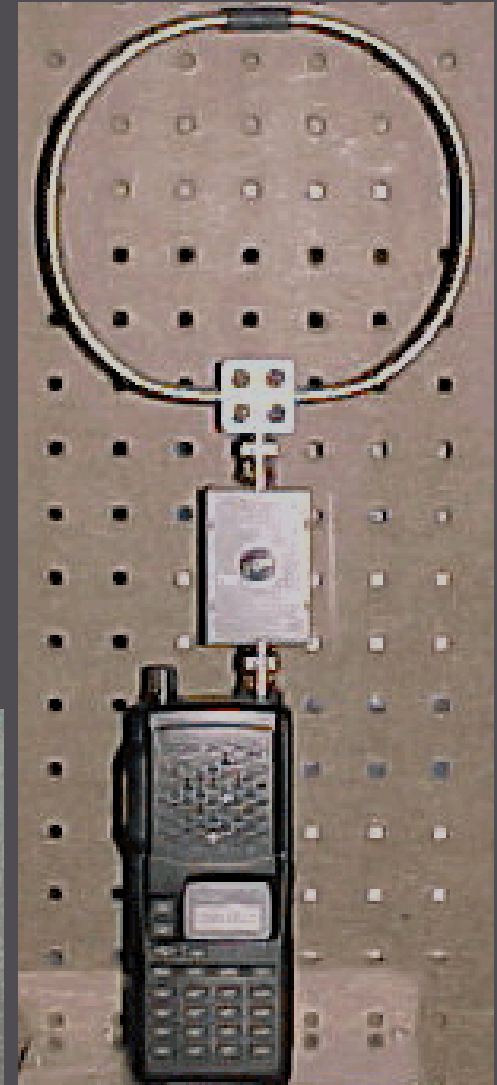
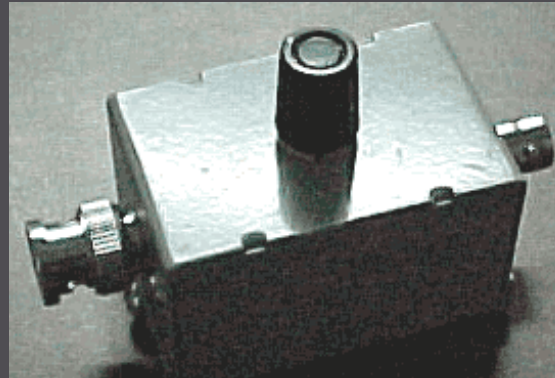
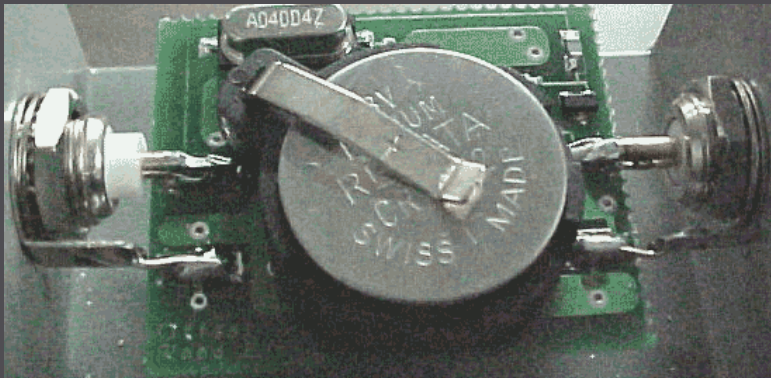
# Joe Moell KØØV Offset Attenuator Kits





# Arrow Antenna Attenuator

- ▣ \$60
- ▣ Includes CR2032 coin cell
- ▣ No enclosure



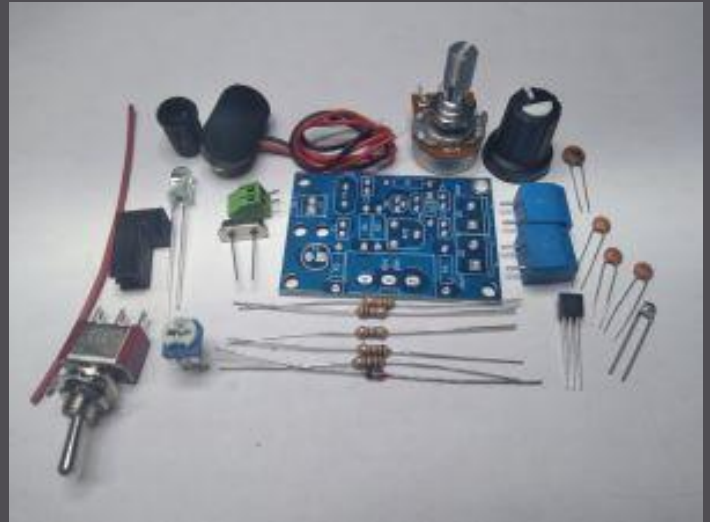
# Byonics AA1 Active Attenuator

- ▣ \$52
- ▣ Includes CR2032 coin cell
- ▣ No enclosure



# 3rd Planet Solar / KC90N Offset Attenuator V5

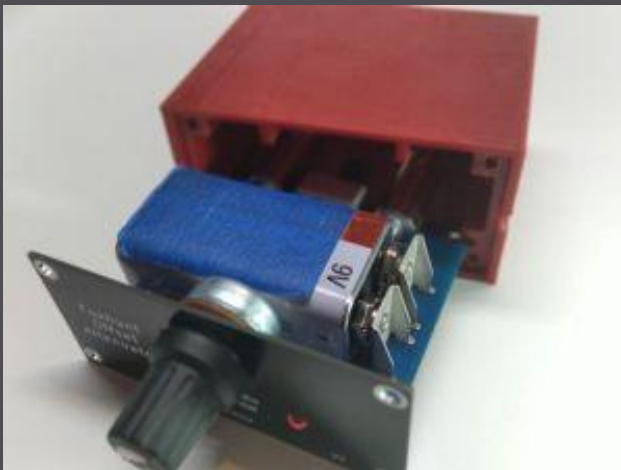
- ▣ \$10 - Kit
- ▣ \$15 - Assembled
- ▣ No enclosure





# 3rd Planet Solar / KC90N Offset Attenuator V7

- ▣ \$26.50 – Kit (SMD components soldered)
- ▣ \$31.50 - Assembled
- ▣ 3D printed PETG enclosure
- ▣ Bypass switch built in
- ▣ SMA or BNC option



# VK3YNG Sniffer 4

- ▣ Bryan Ackerly VK3YNG in Australia
- ▣ Frequency-synthesized
- ▣ Lightweight, one-piece receiver/antenna set
- ▣ Tone-pitch signal-strength indicator
- ▣ Automatic-ranging attenuation in 15 dB steps
- ▣ \$150 shipped to US [www.foxhunt.com.au/](http://www.foxhunt.com.au/)





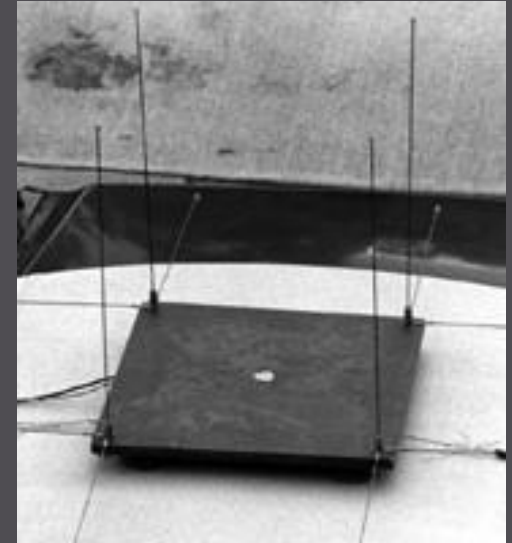
# VK3YNG Sniffer 4 Demo





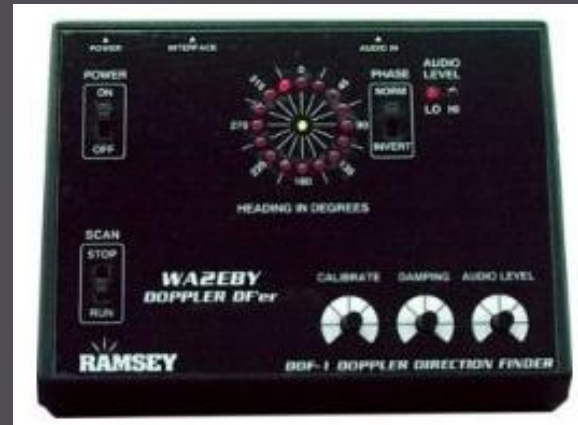
# Roanoke Doppler Design

- ▣ Build your own kit

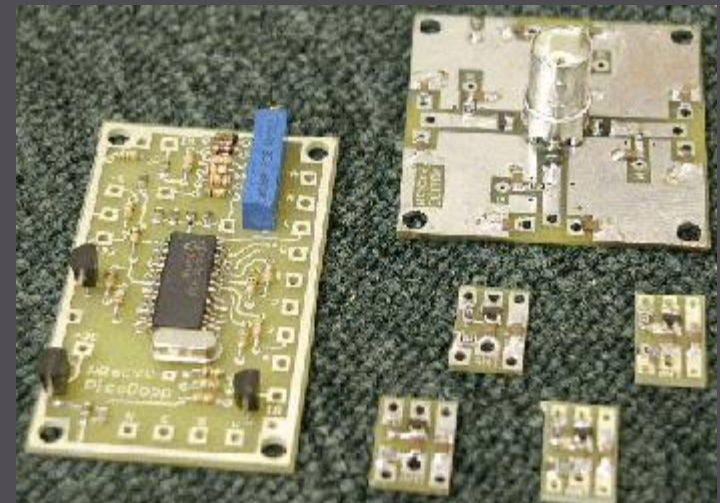


# Doppler Kits

- ▣ Ramsey doppler \$169.95 (eBay?)



- ▣ PicoDopp
- ▣ DSP / GPS Doppler DF
- ▣ \$169





# DF2020T Doppler (Kit) GLOBAL TSCM GROUP

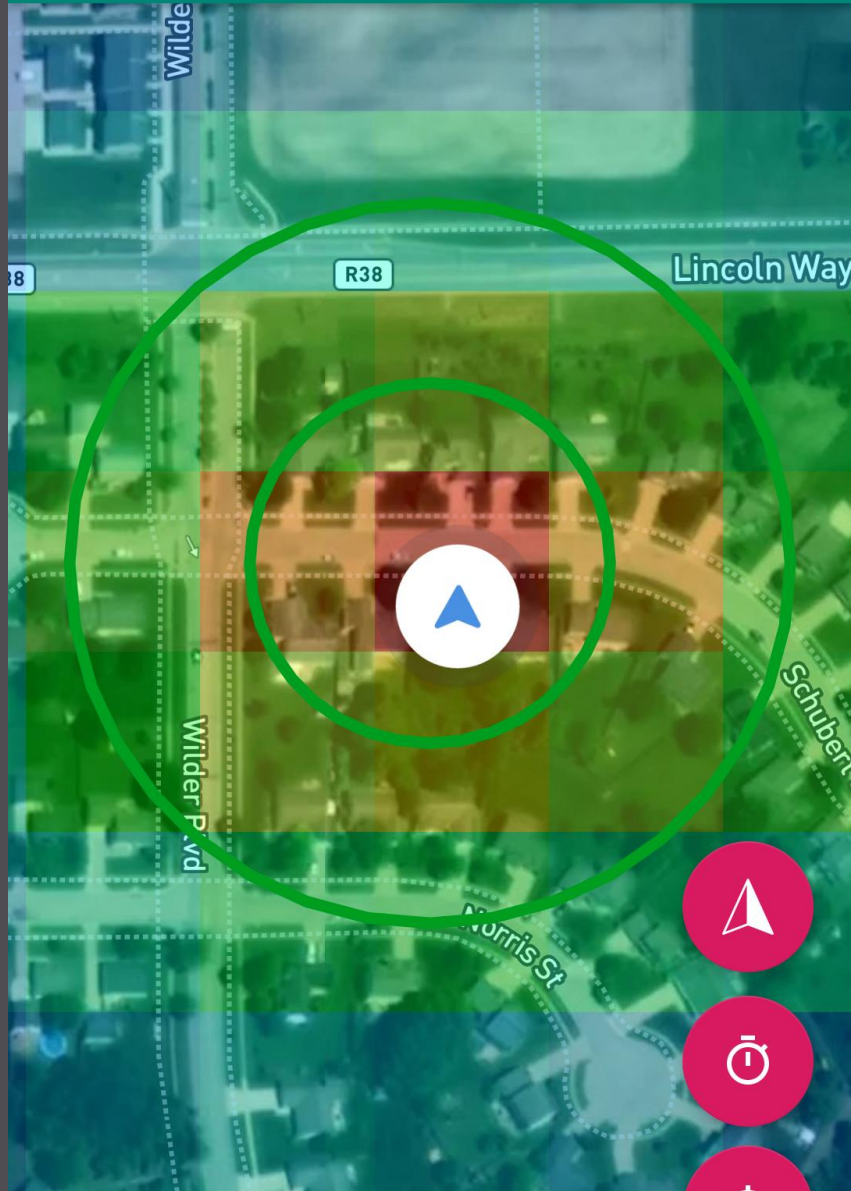
- ▣ Numeric & 36 LED display
- ▣ Navi2020 map plotting display program (with the optional GPS Receiver)
- ▣ Uses GoogleEarth™ viewer for displaying map of plotting
- ▣ Add receiver and PC
- ▣ \$398



# KerberosSDR - 4 Channel Coherent RTL-SDR

- ▣ Four synced RTL-SDRs with common clock
- ▣ Custom software for direction finding and passive radar included
- ▣ Frequency Range: 24 MHz - 1.7 GHz
- ▣ Shielded metal enclosure
- ▣ \$249 Discontinued





9761  
test3\_3.15.24.csv

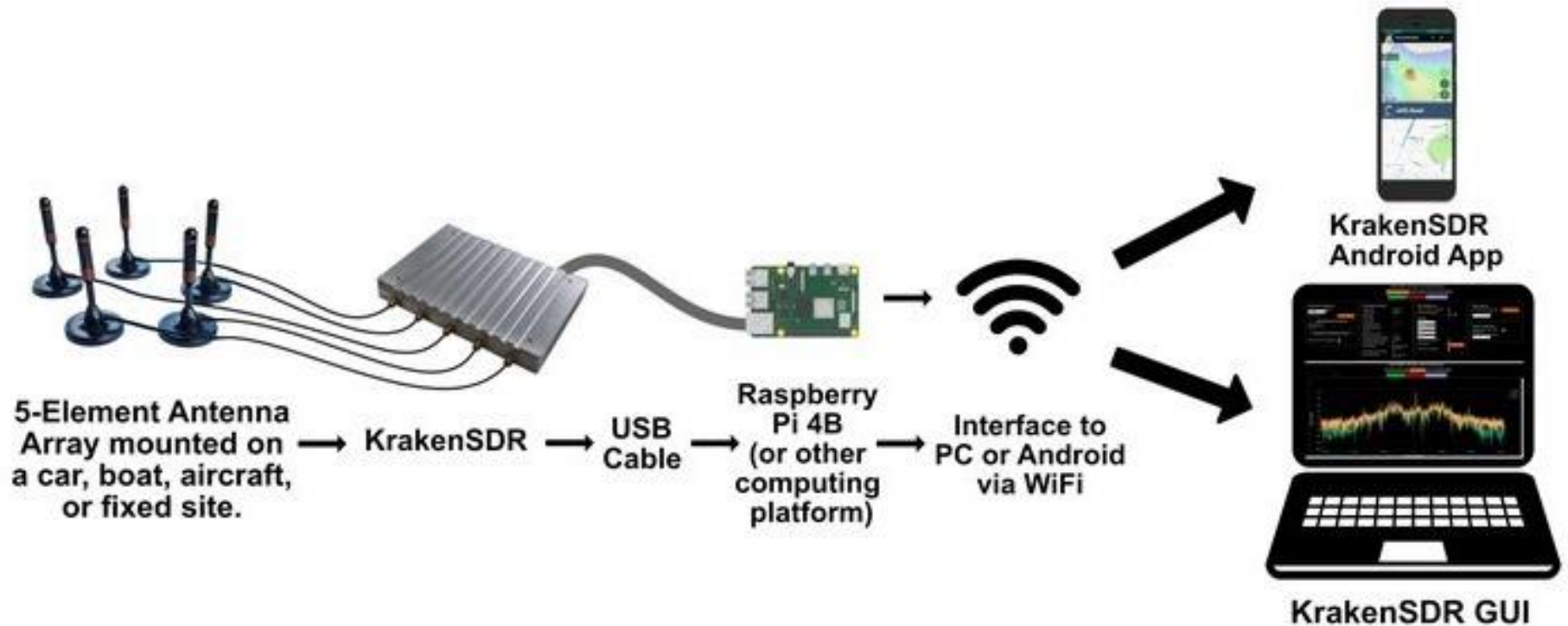


# Kraken SDR - 5 Channel Coherent RTL-SDR

- ▣ Five channel common clocked RTL-SDR
- ▣ Built in noise source
- ▣ Automatic phase synchronization hardware
- ▣ Kraken \$499
- ▣ Five Magnet-Mounted Antennas \$199



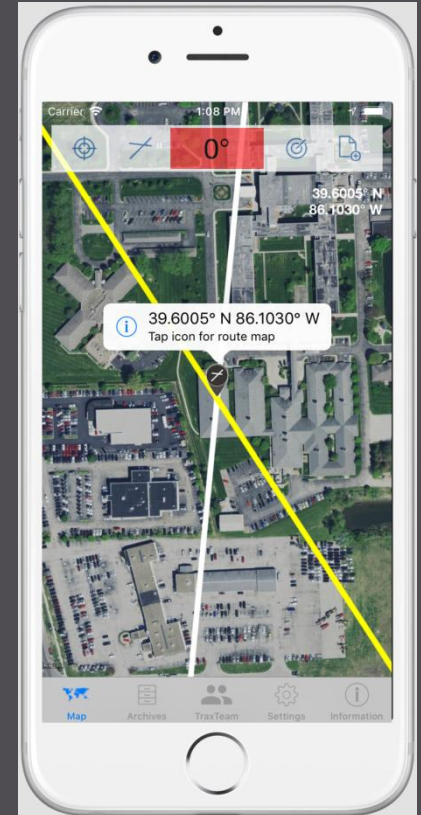
# Kraken SDR - 5 Channel Coherent RTL-SDR



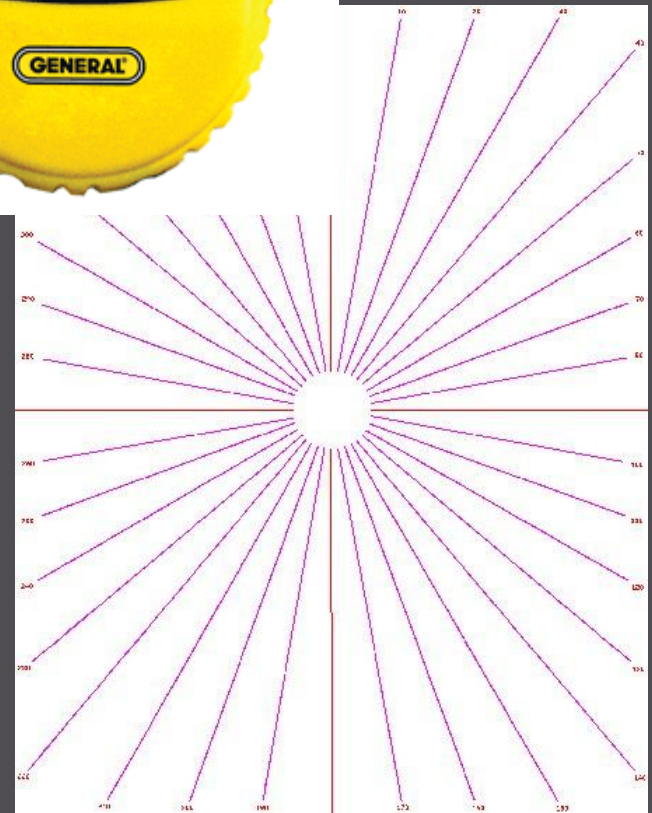
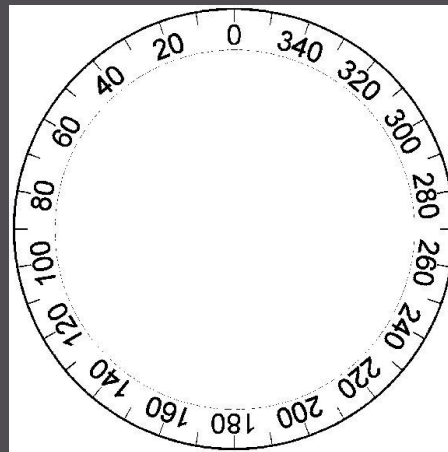


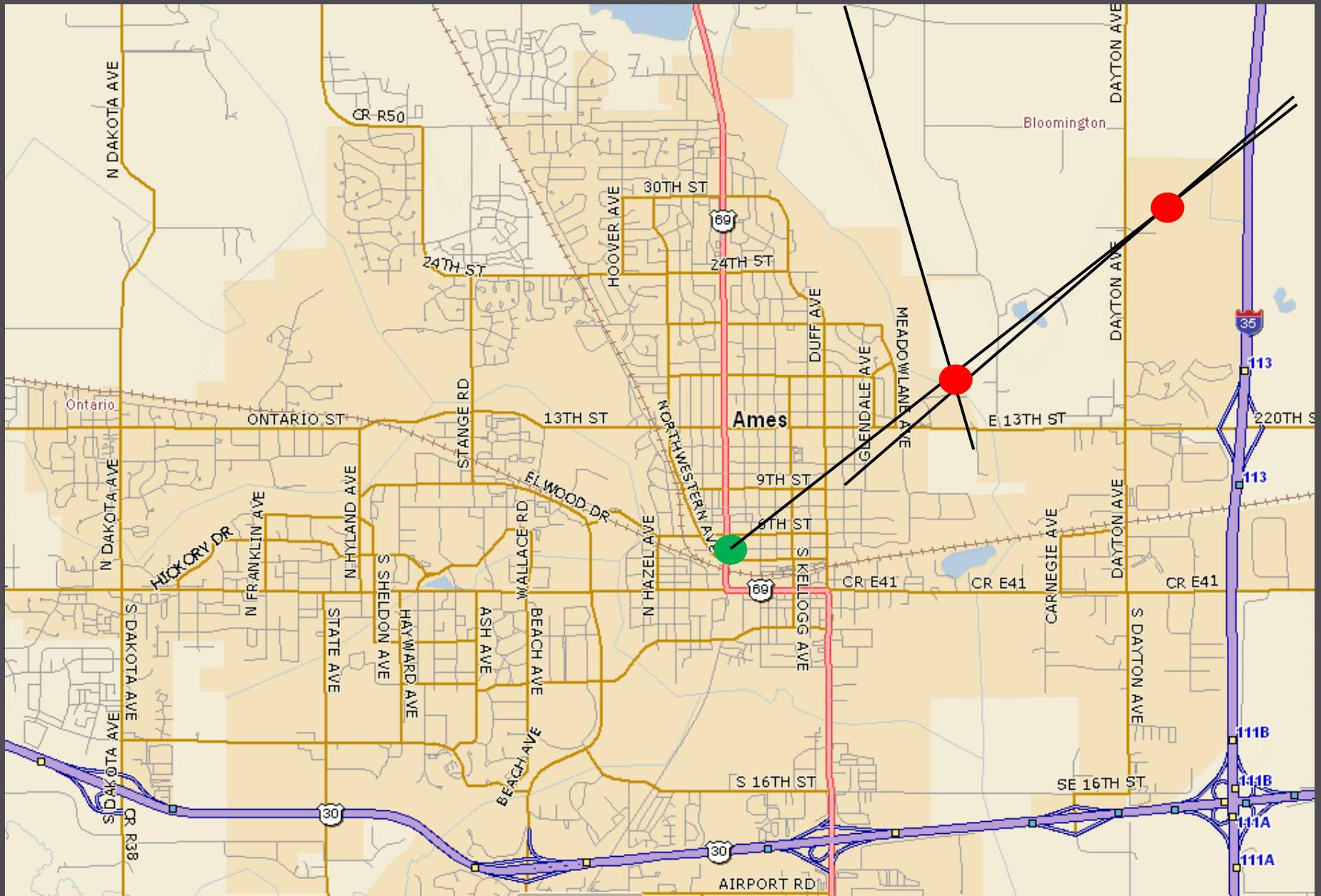
# SigTrax iOS and Android app

- ▣ Use triangulation method to pinpoint locations
- ▣ GSP accuracy and precision mapping on mobile device
- ▣ Integrated compass – point and tap to save bearing
- ▣ iOS \$2.99
- ▣ Android \$3.99



# Extra Equipment





# Hider Options

- ▣ First to find or least miles on odometer?
- ▣ Vertical or horizontal polarization?
- ▣ Day or Night?
- ▣ Timing?
- ▣ Antenna?
- ▣ All start in one place or random?
- ▣ Teams?
- ▣ Hints?



# Resources

- ▣ <https://storyares.org/downloads>
- ▣ [kb7vml.net/downloads](http://kb7vml.net/downloads)
- ▣ [www.homingin.com](http://www.homingin.com)

1/7/2016 SCARC Presentation: 12 volt Wiring and Powerpoles

11/6/2014 SCARC Presentation: Introduction to Digital EmComm with NBEMS

11/7/2013 SCARC Presentation: Story ARES Emergency Operations Plan Overview

10/4/2012 SCARC Presentation: Personal Preparedness (Handout from Presentation)

10/6/2011 SCARC Presentation: Formal Messaging

**Fox Hunting 101 Presentation**

ARES Field Resources Manual

ARES Public Service Communications Manual

ARES Manual (2015 edition)

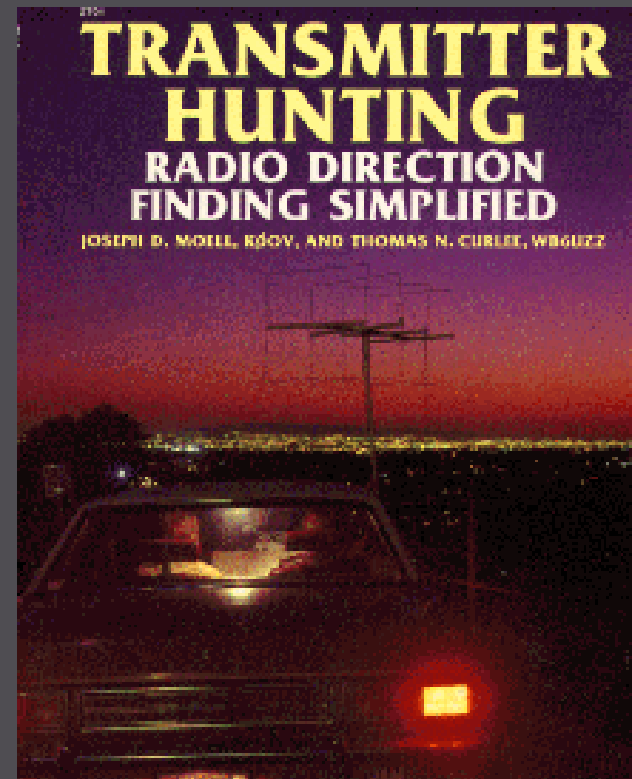
Auxiliary Communications Field Operations Guide (AUXFOG) and National Interoperability

ARES Standardized Training Plan Task Book [Fillable PDF] or [Microsoft Word]

Iowa Section ARES Taskbook v2.0.2

*(Please note that these taskbooks have been adopted at the National and Section levels but not yet adopted currently be used for reference only for Story County ARES)*

Forms



# Ready to Fox Hunt?



- ▣ Story County Amateur Radio Club is hosting a fox hunt
- ▣ Sunday, March 17<sup>th</sup>, 2pm – 4pm
- ▣ Parking lot west of Hy-Vee Gas, Grand Avenue and Lincoln Way
- ▣ 146.430 MHz FM simplex
- ▣ Fox will be hidden in somewhere in the Ames city limits
- ▣ Second, more difficult fox 146.460 MHz FM simplex

