

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

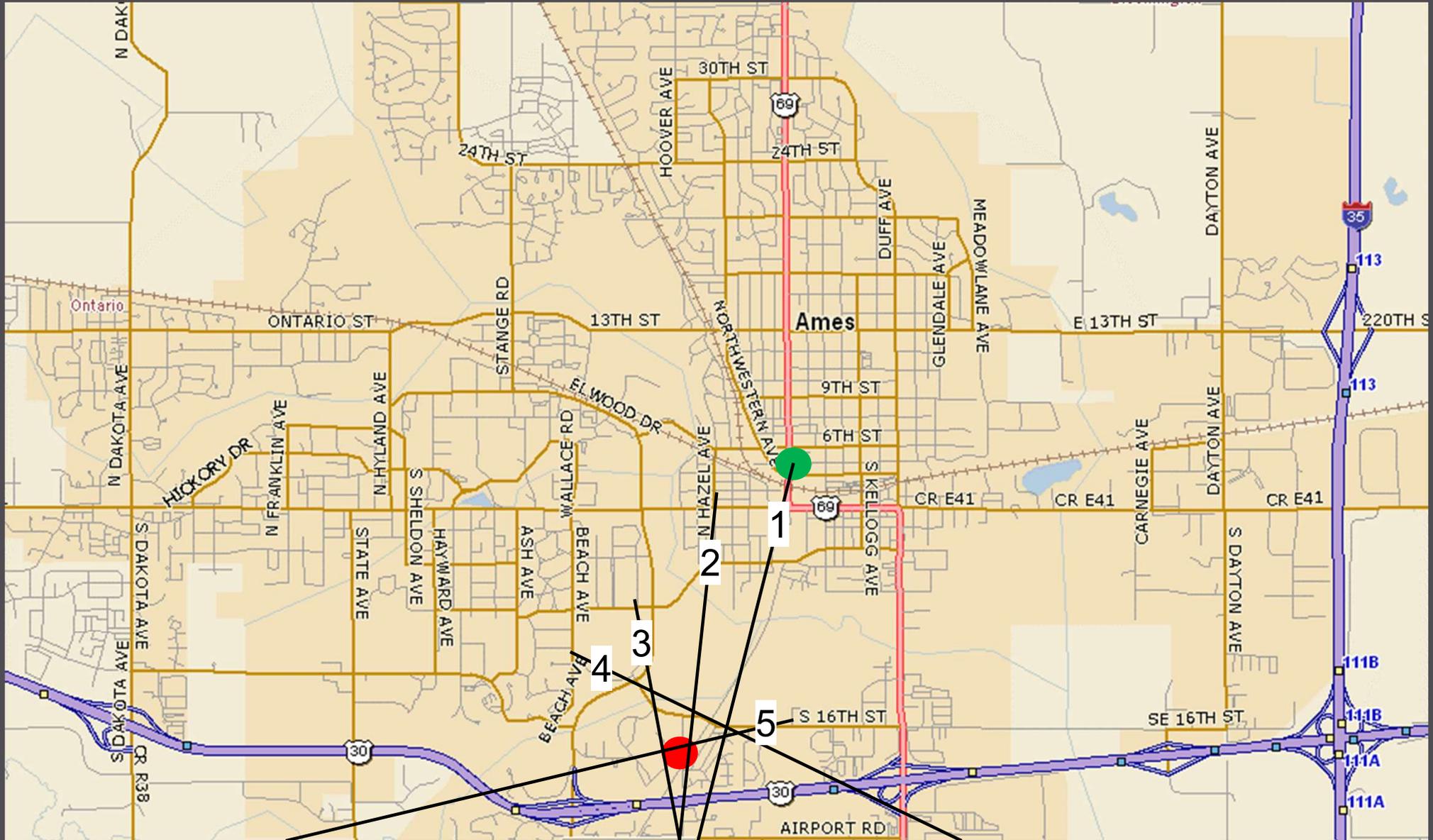
Why Fox Hunt?

- ▣ 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



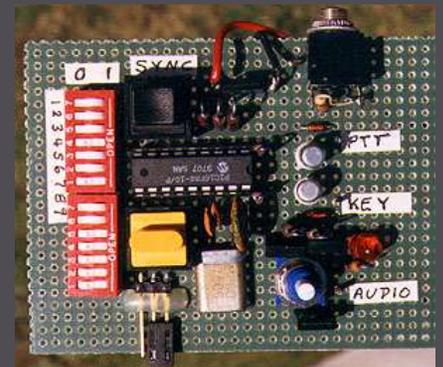
Fox Boxes for 2 Meters

- ▣ 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



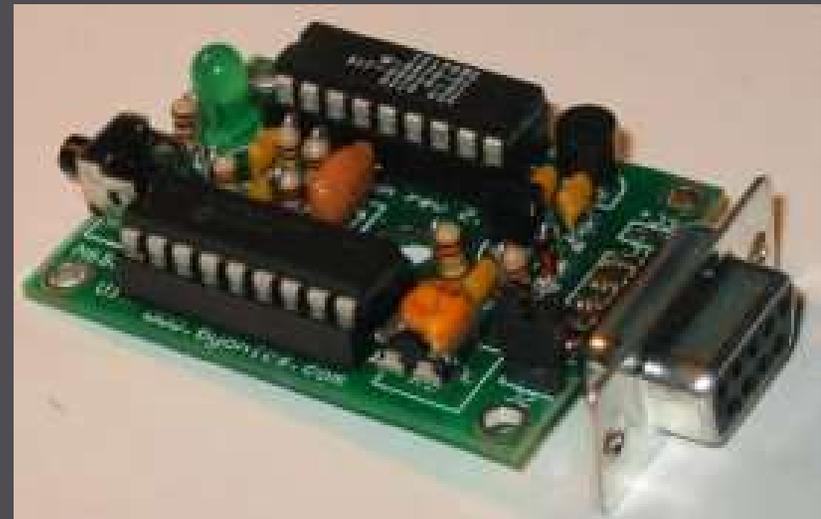
Build-Your-Own Radio Controller Kits

- ▣ 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



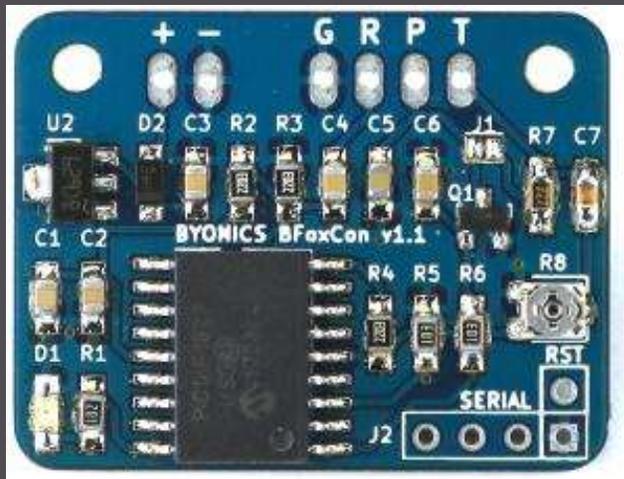
Build-Your-Own Byonics PIC Microcontroller Based Radio Controllers

- ▣ 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

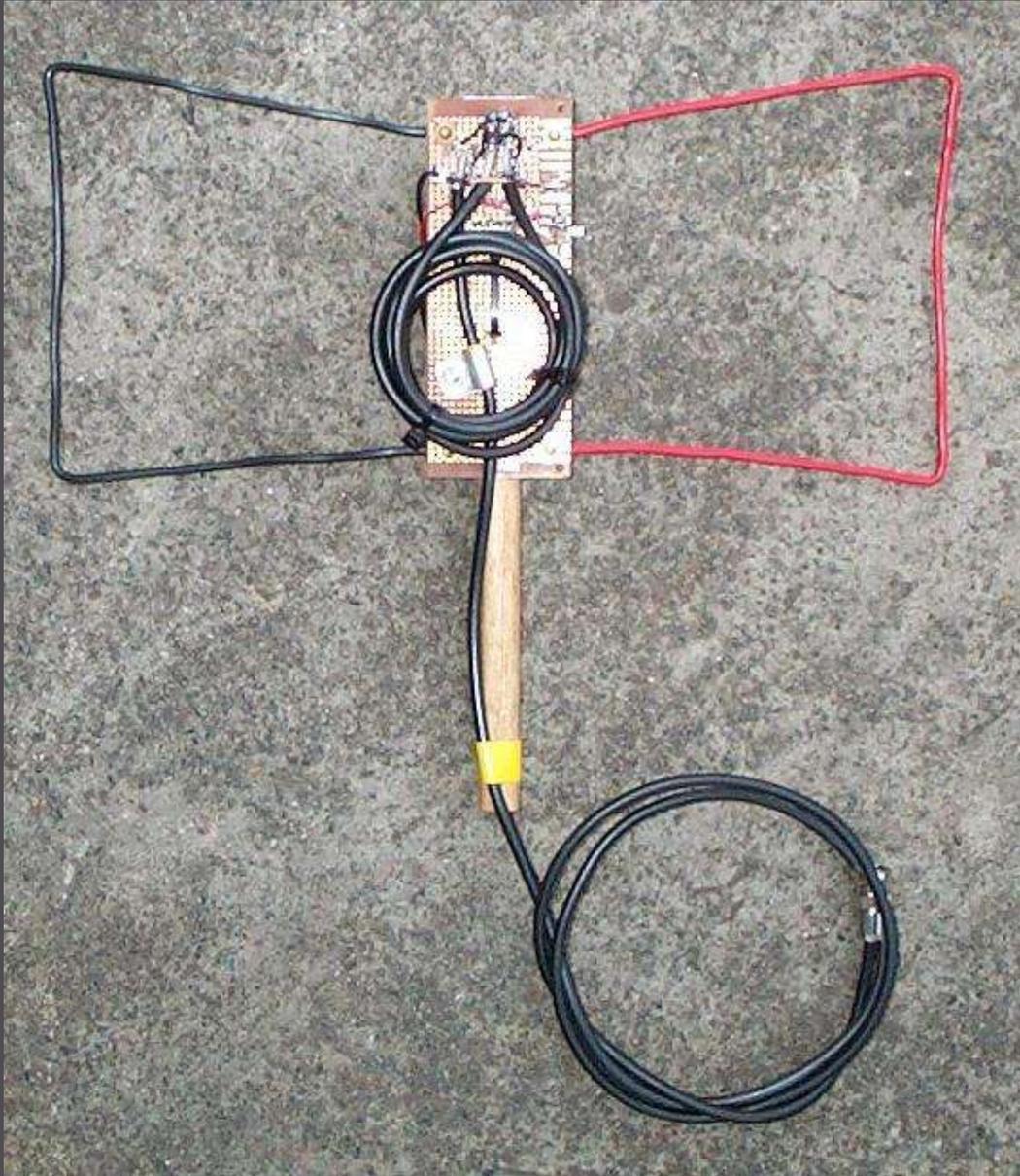


- ▣ Arrow Antennas VHF Fox Hunt Loop \$79
- ▣ BNC mounts directly on HT or 4 MHz offset attenuator

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

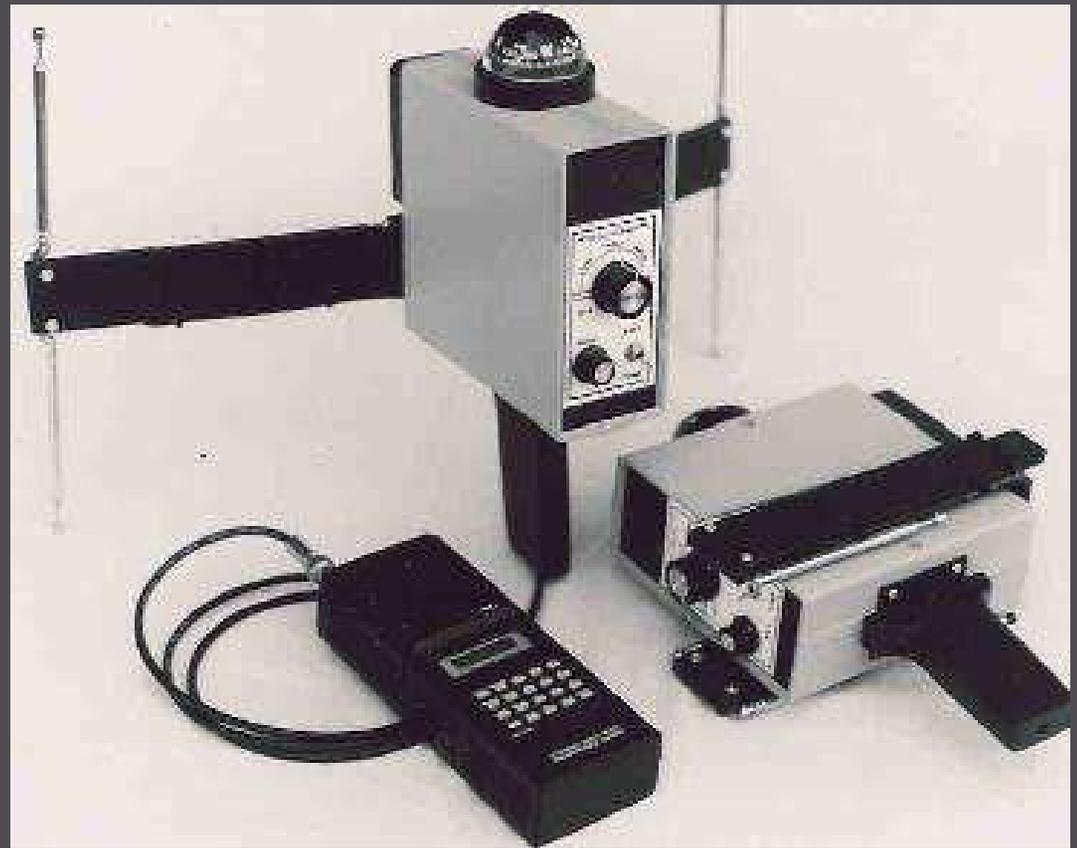


\$29.95

handi-finder.com

FM-based Dual-Antenna Sets

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



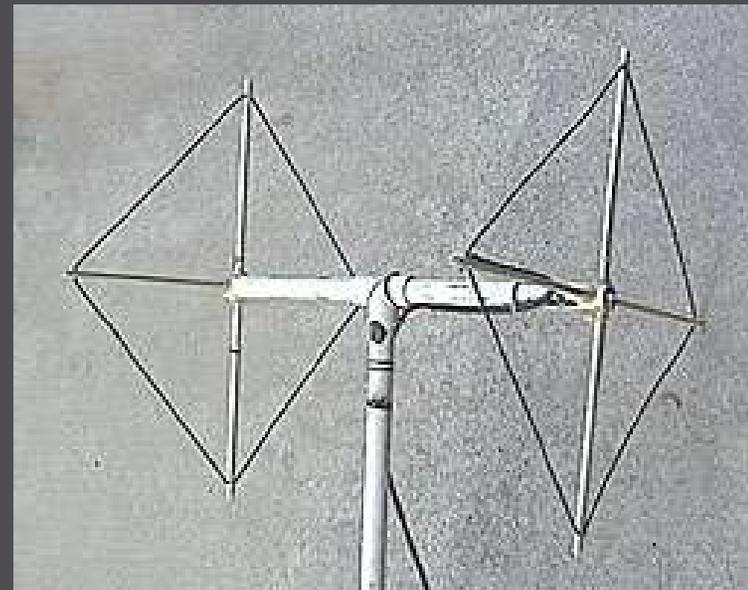
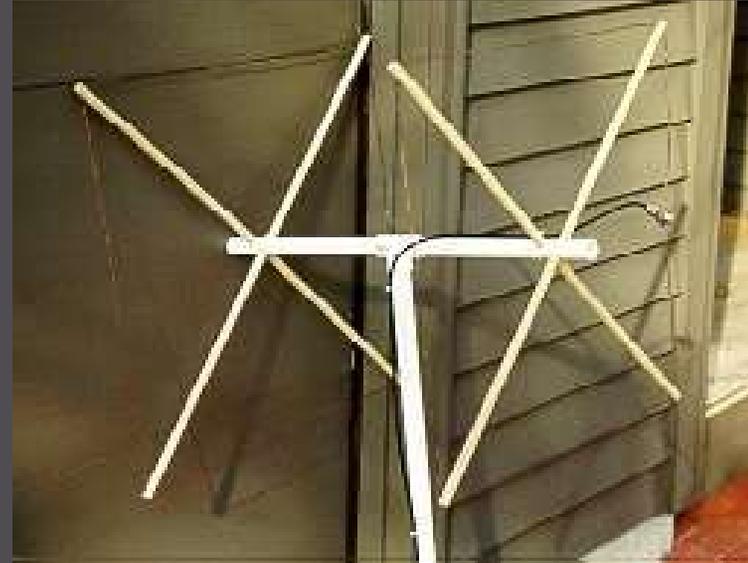
Directional Antennas

- ▣ 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, \$140
 - 7+ dbi gain at 145 MHz
 - F/B > 21dB
 - 16" boom
 - 21" Turn Radius



- ▣ Yellow Jacket
 - 4 element, \$180
 - 9+ dbi gain
 - Elements 21"
 - Boom 42" long



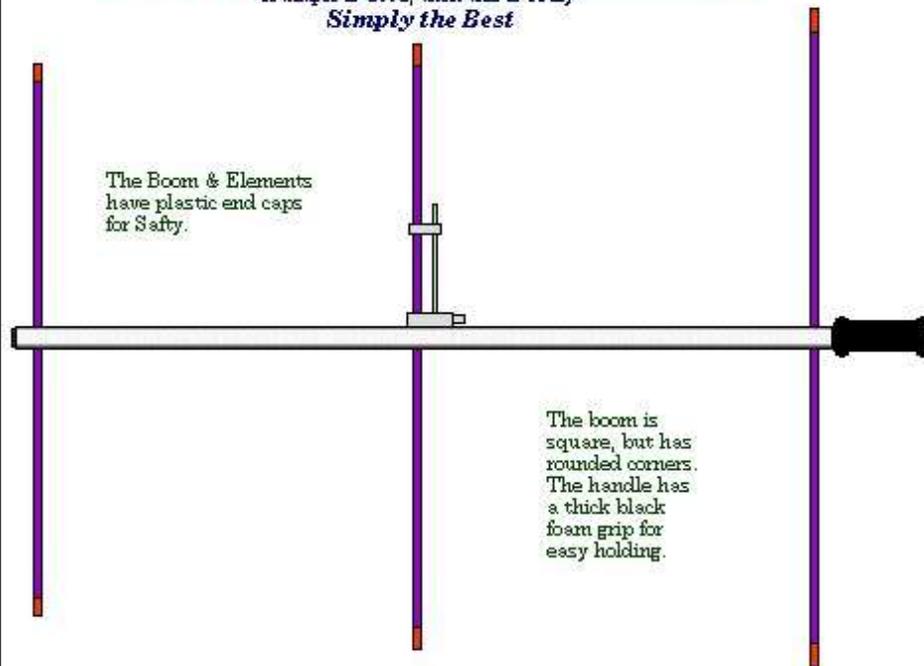
DIY 3 Element Yagi



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.
SWE 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

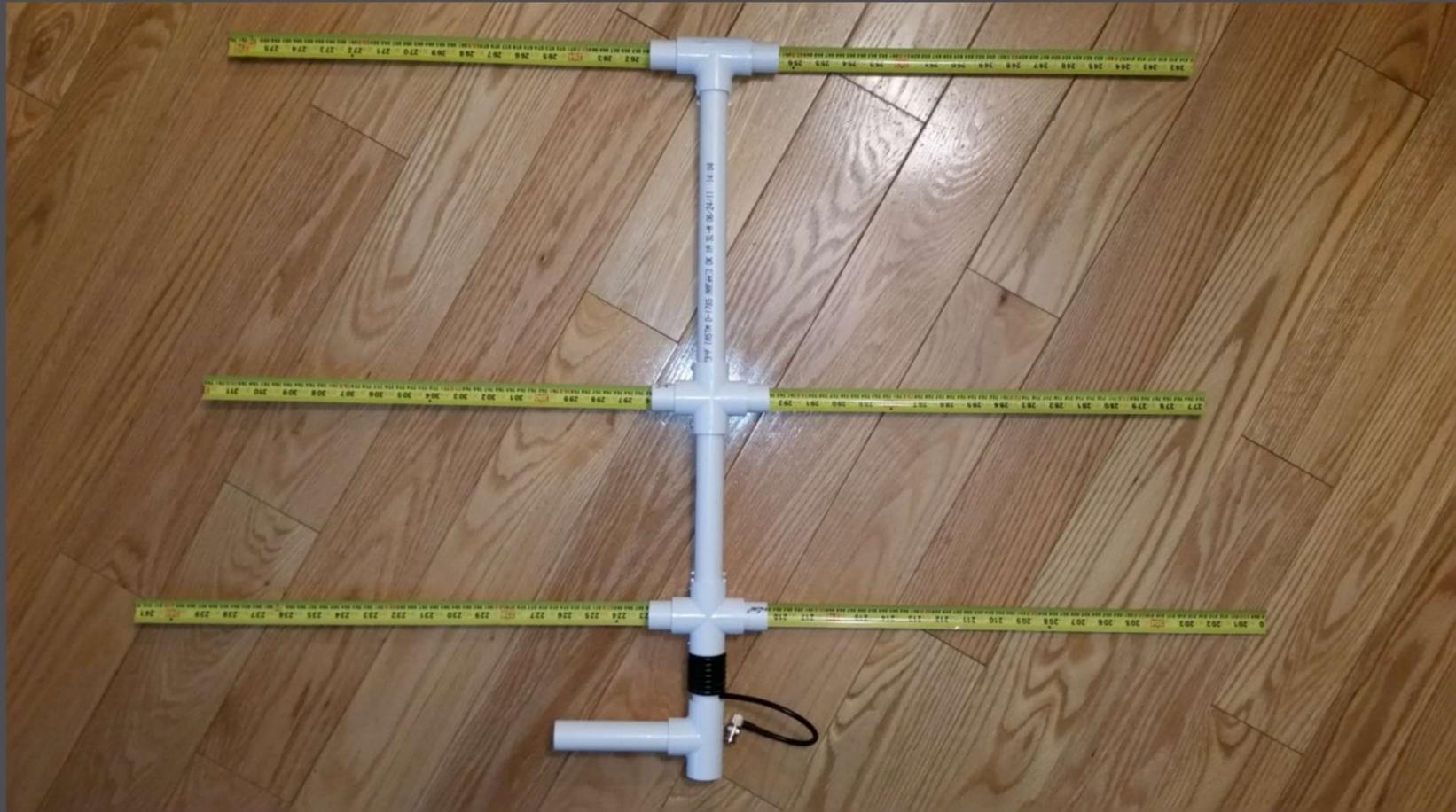
15 oz.



\$114

Tape Measure Yagi

Joe Leggio WB2HOL



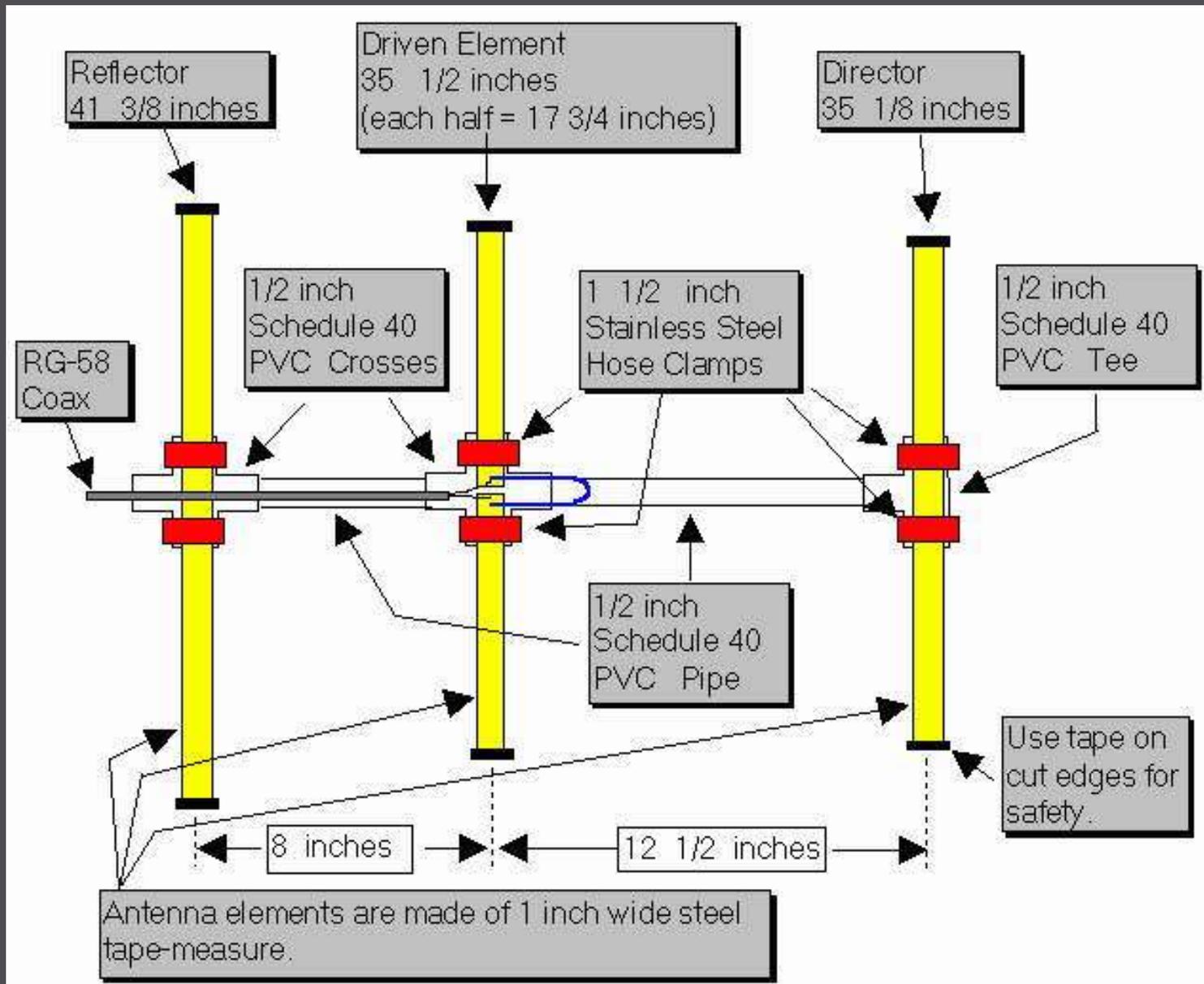
Tape Measure Yagi

- ▣ 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
- ▣ 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

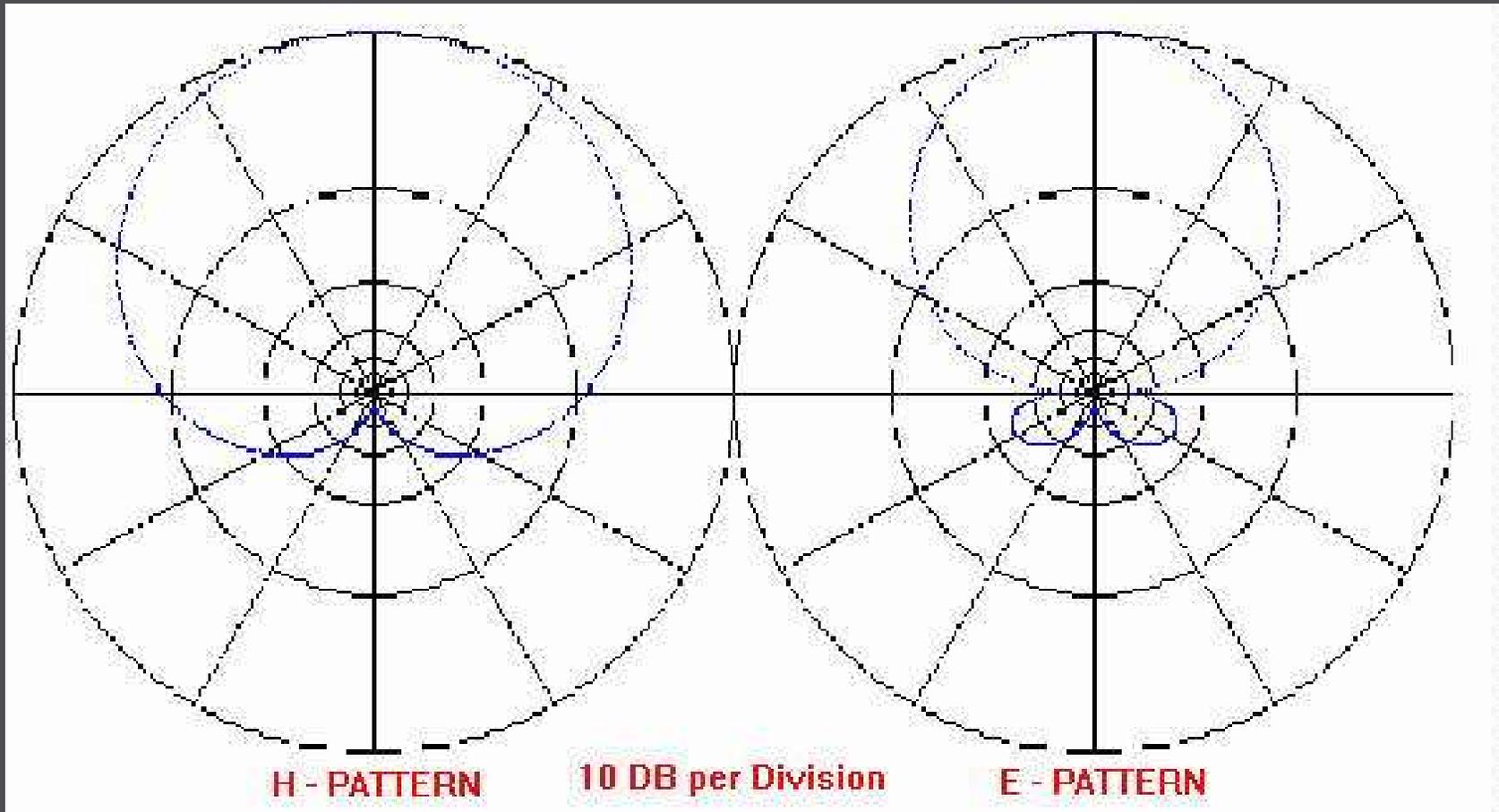
Tape Measure Yagi

- ▣ 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



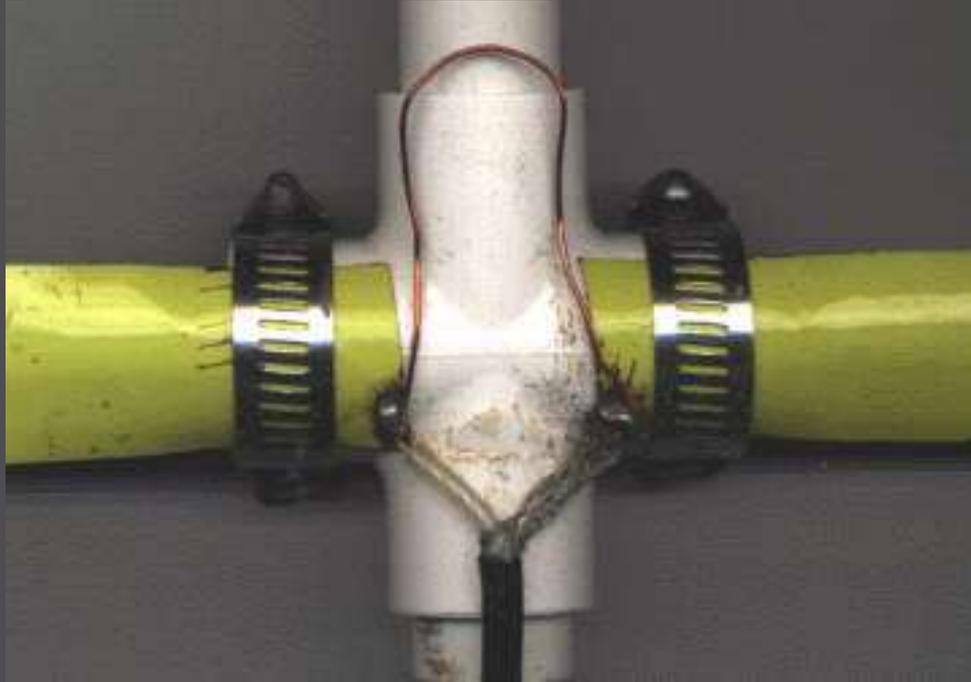
Tape Measure Yagi



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

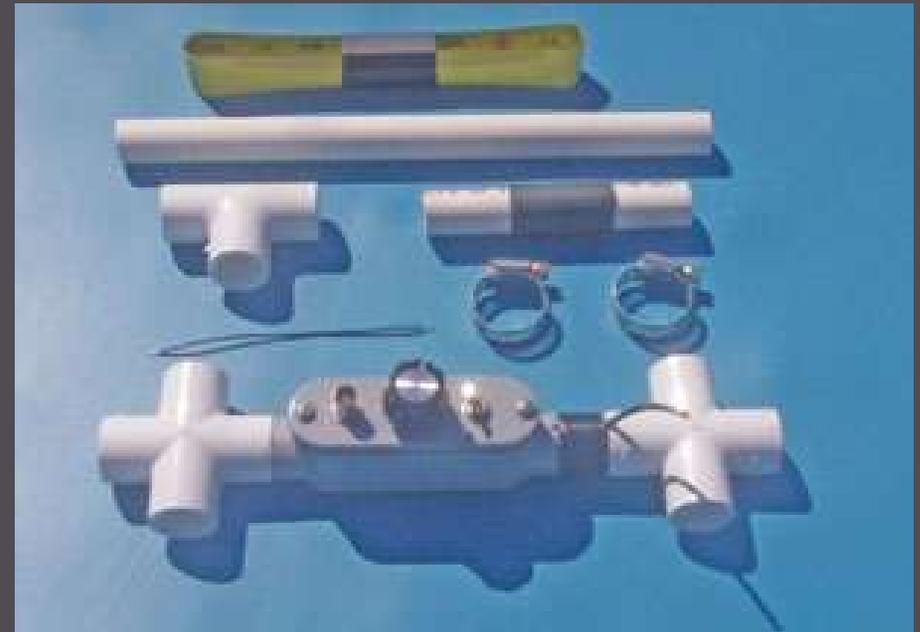
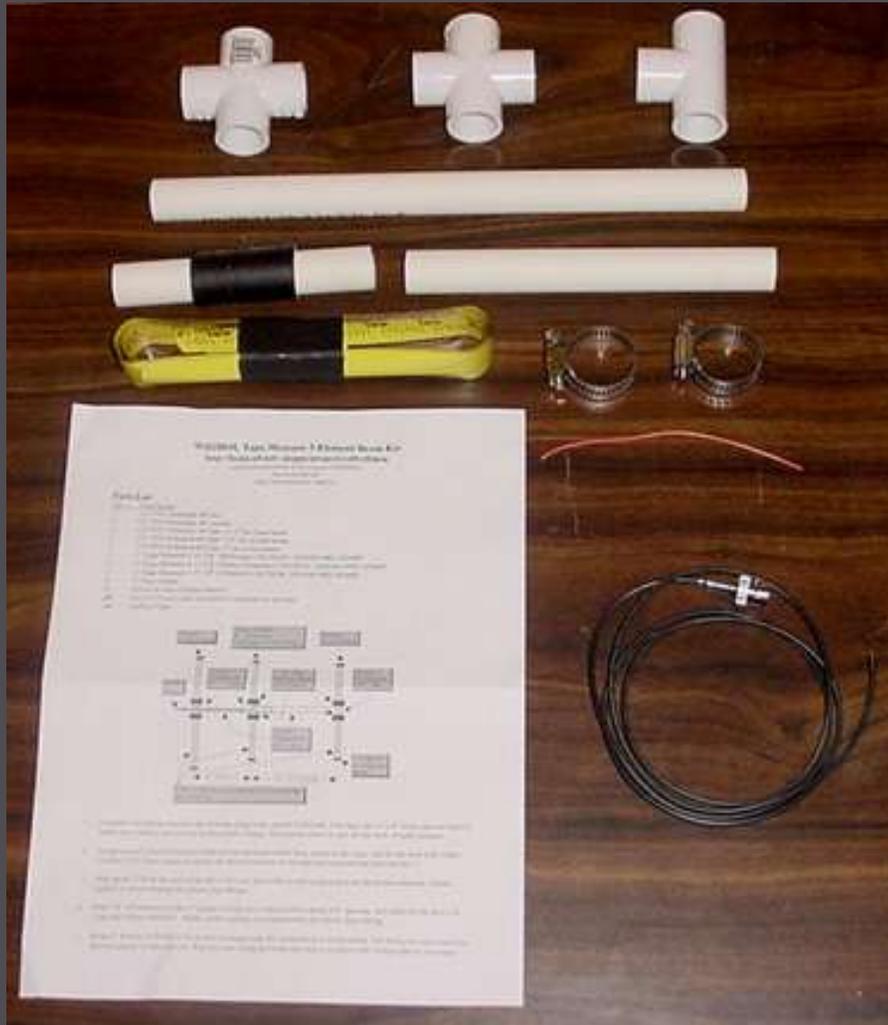
Element Connection Options



- ❑ 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



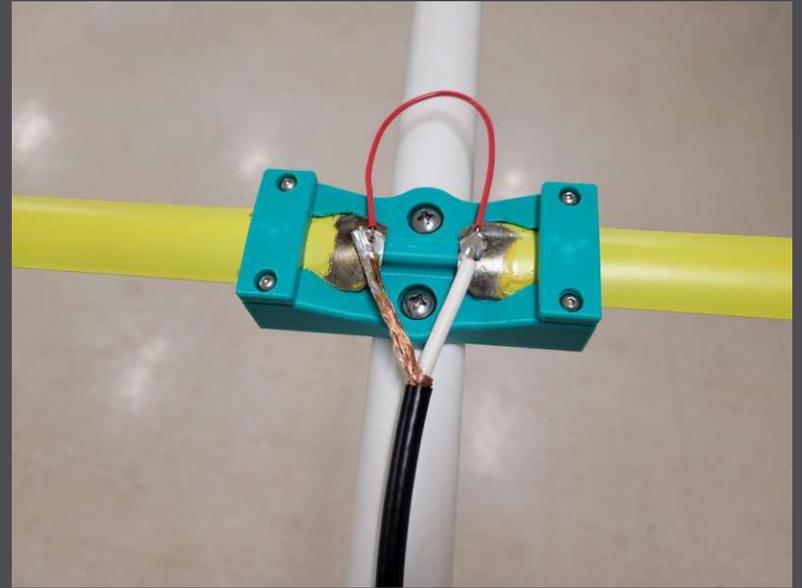
K0GR and W0YR “Tape Measure” Yagi Antenna Workshop Files

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

Steps 13, 14, and 15



3D Printed Parts



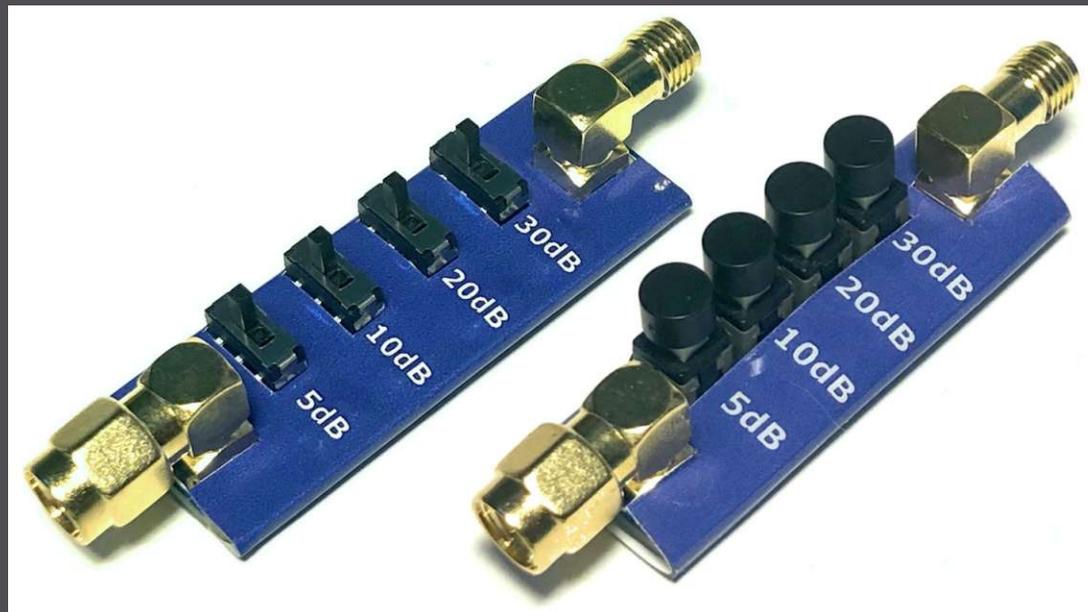
Attenuation:

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

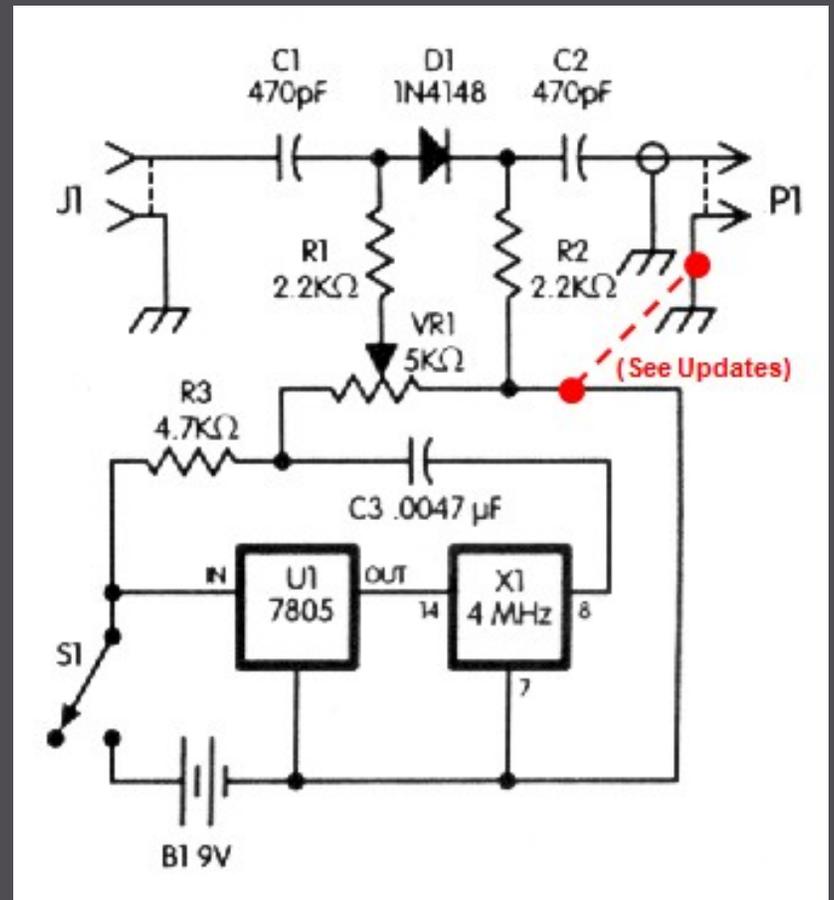


Offset Attenuator

- ▣ 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

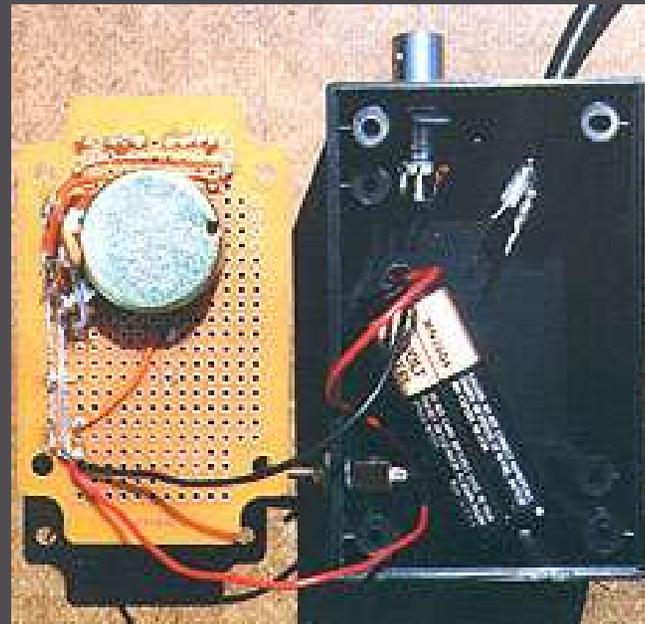
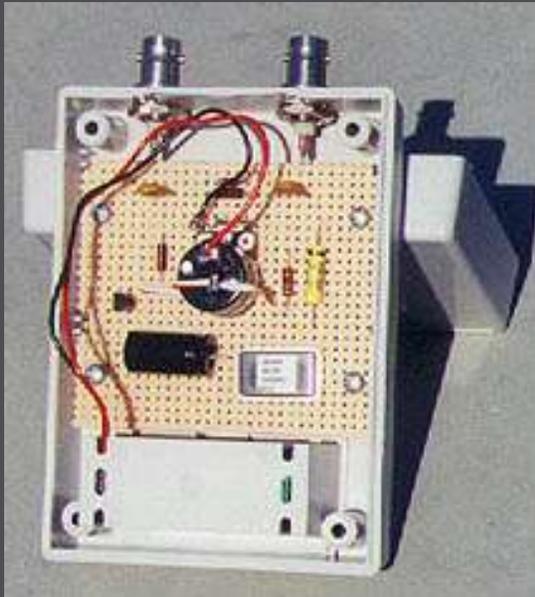
- Local oscillator connected to a diode mixer
- Shift receiver frequency 2 MHz or 4 MHz from transmitted frequency
- 20 dB to 100 dB or more attenuation



Offset Attenuator Demo



Joe Moell KØOV Offset Attenuator

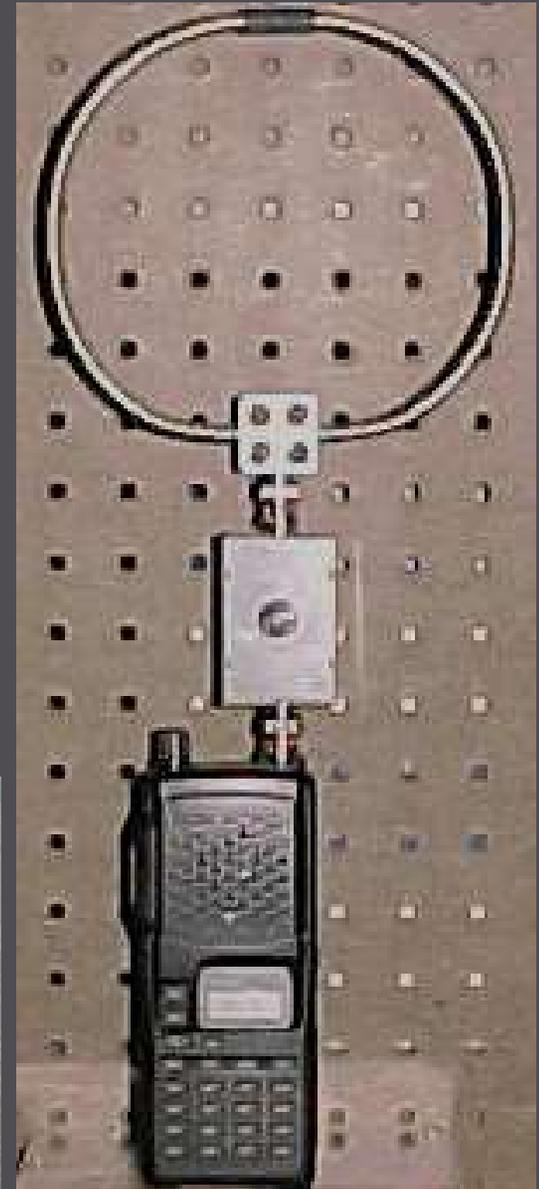
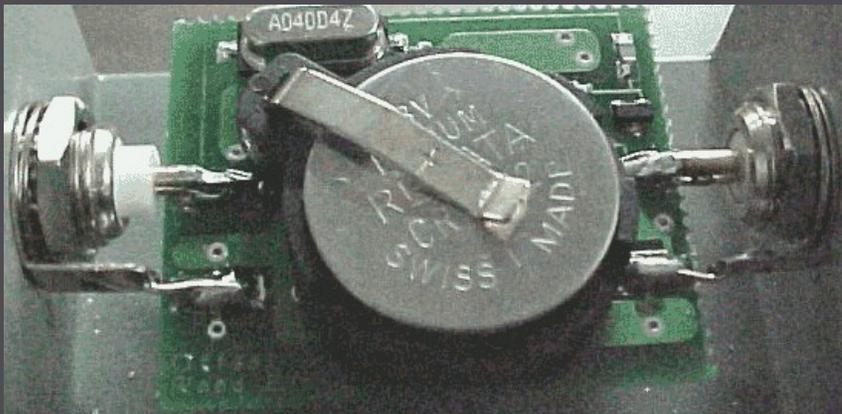


Joe Moell KØØV Offset Attenuator Kits



Arrow Antenna Attenuator

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



Byonics AA1 Active Attenuator

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



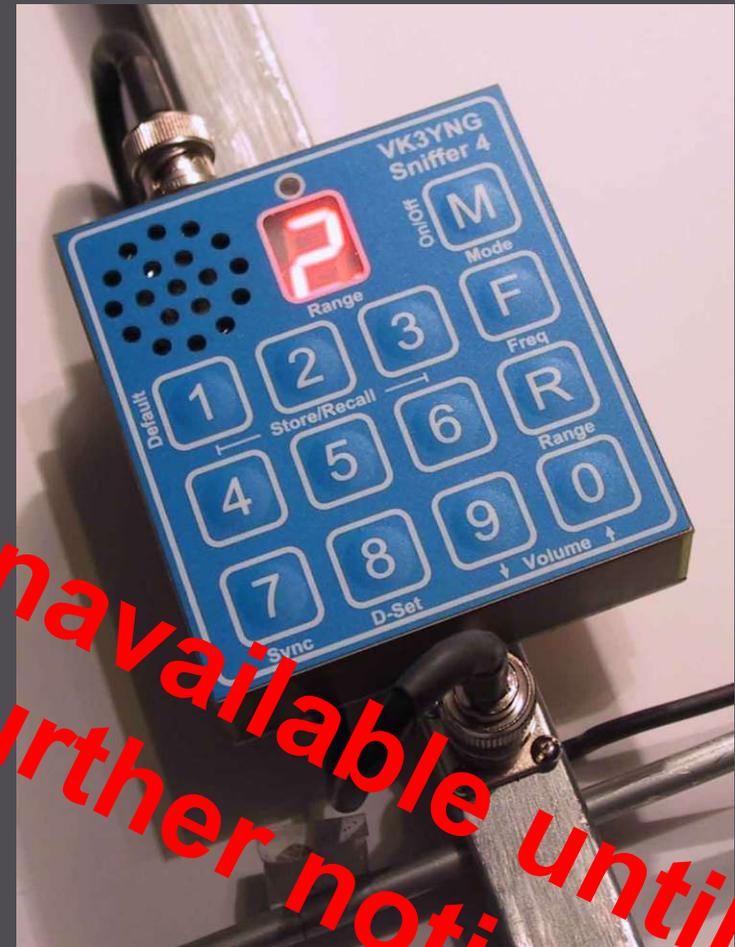
3rd Planet Solar / KC90N Offset Attenuator V7

- ▣ \$28 – Kit (SMD components soldered)
- ▣ \$35 - 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/



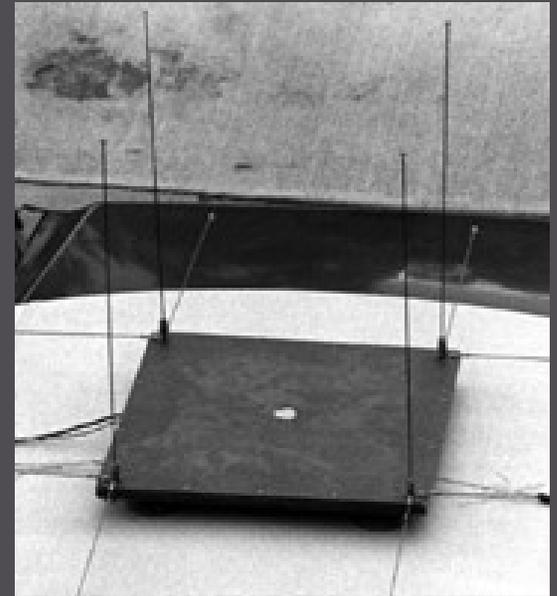
Unavailable until further notice

VK3YNG Sniffer 4 Demo



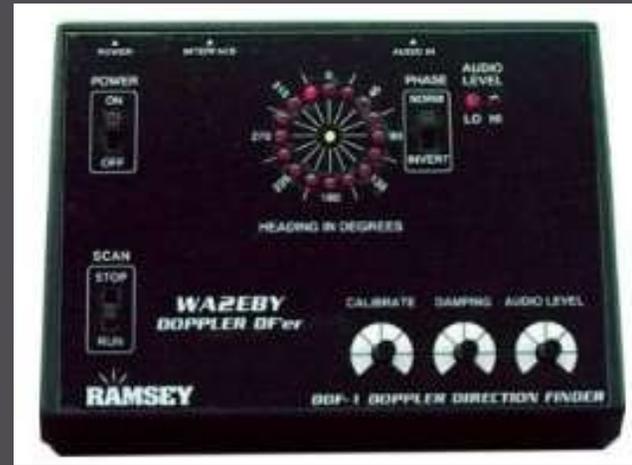
Roanoke Doppler Design

- ▣ Build your own kit

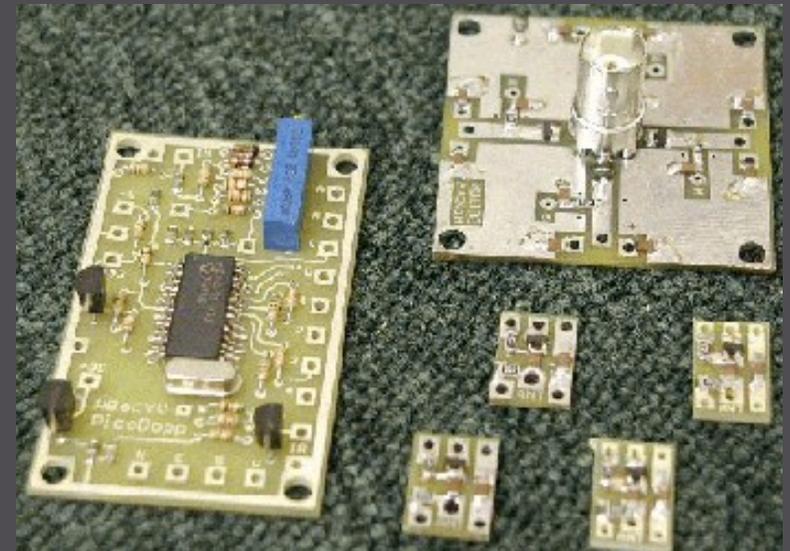


Doppler Kits

- ▣ Ramsey doppler \$169.95 (eBay?)



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



DF2020T Doppler (Kit)

GLOBAL TSCM GROUP

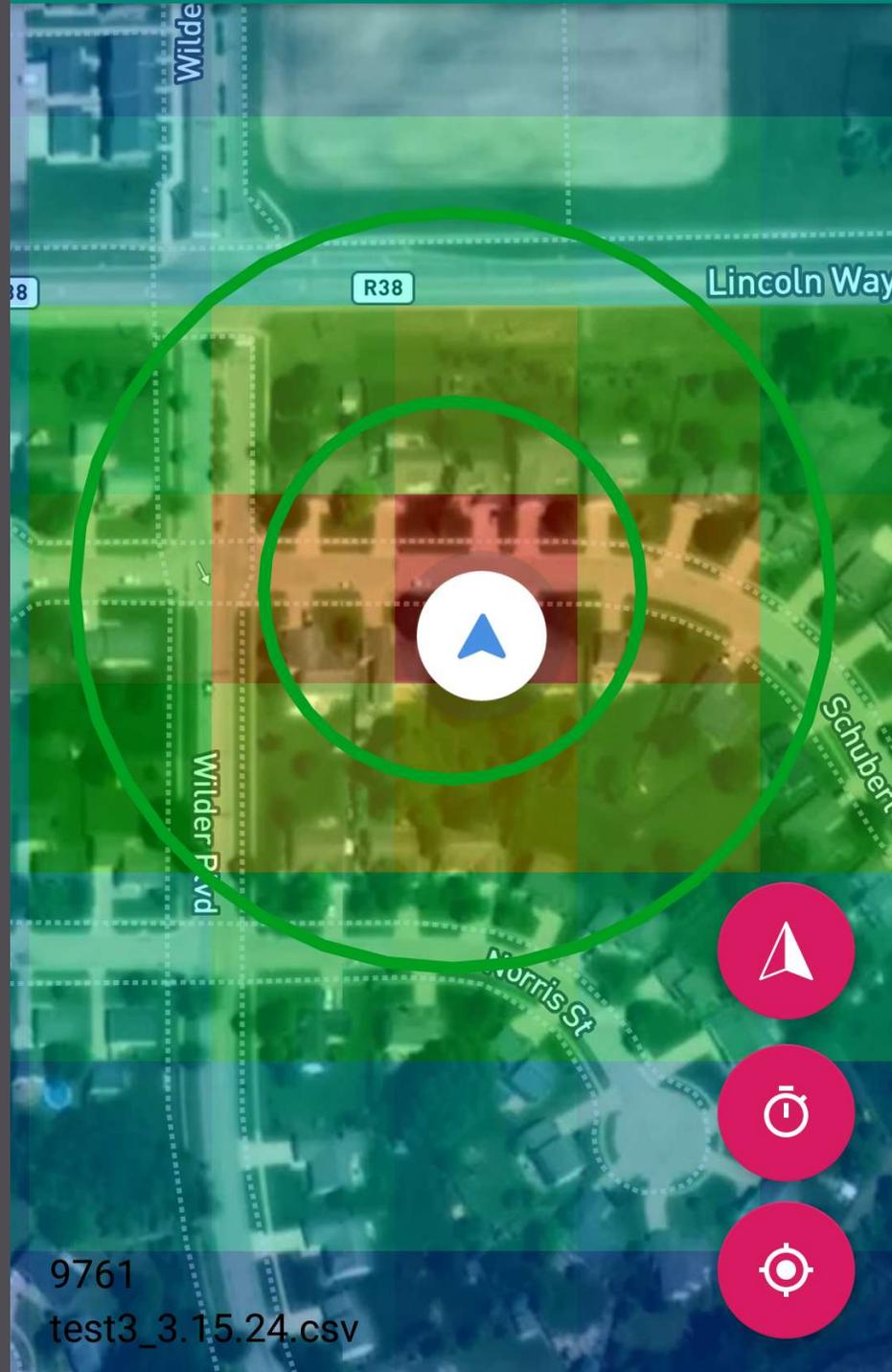
- ▣ Numeric & 36 LED display
- ▣ Navi2020 map plotting display program (with the optional GPS Receiver)
- ▣ Uses GoogleEarth™ viewer for displaying map of plotting
- ▣ Add receiver and PC
- ▣ \$398



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





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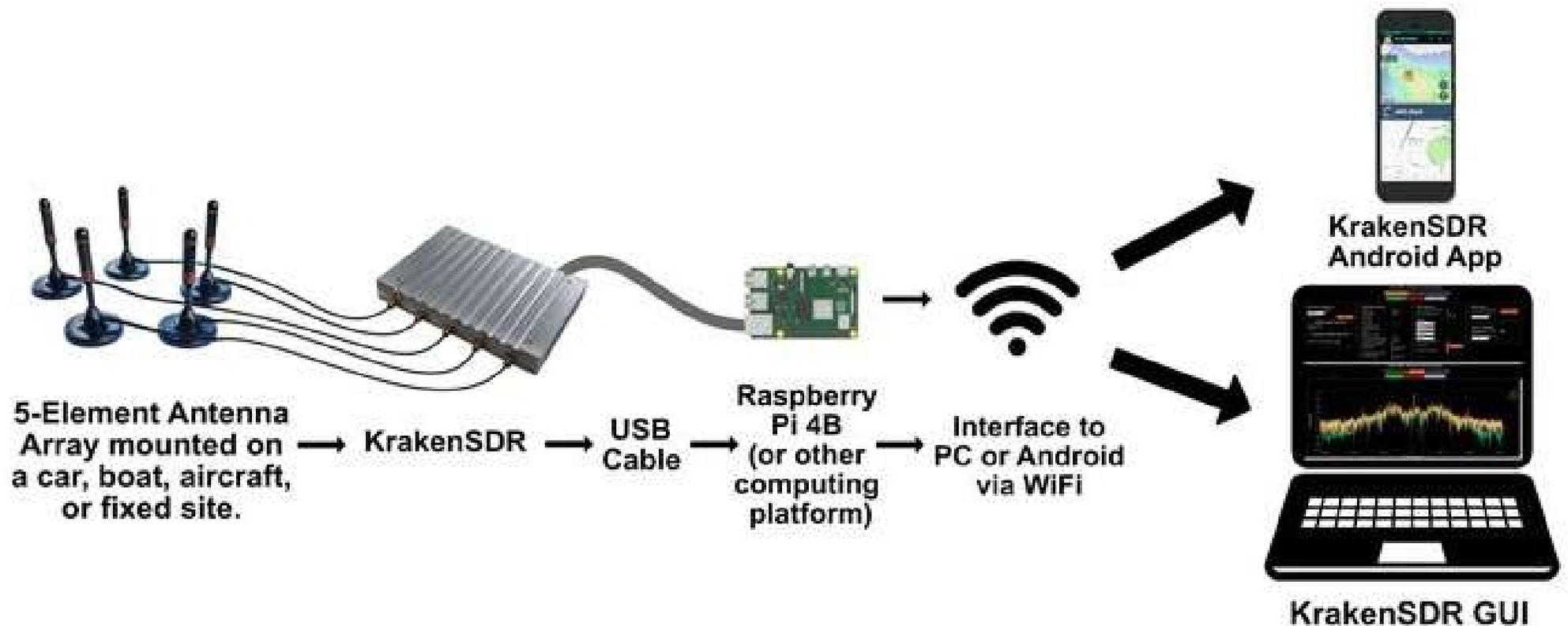


Kraken SDR - 5 Channel Coherent RTL-SDR

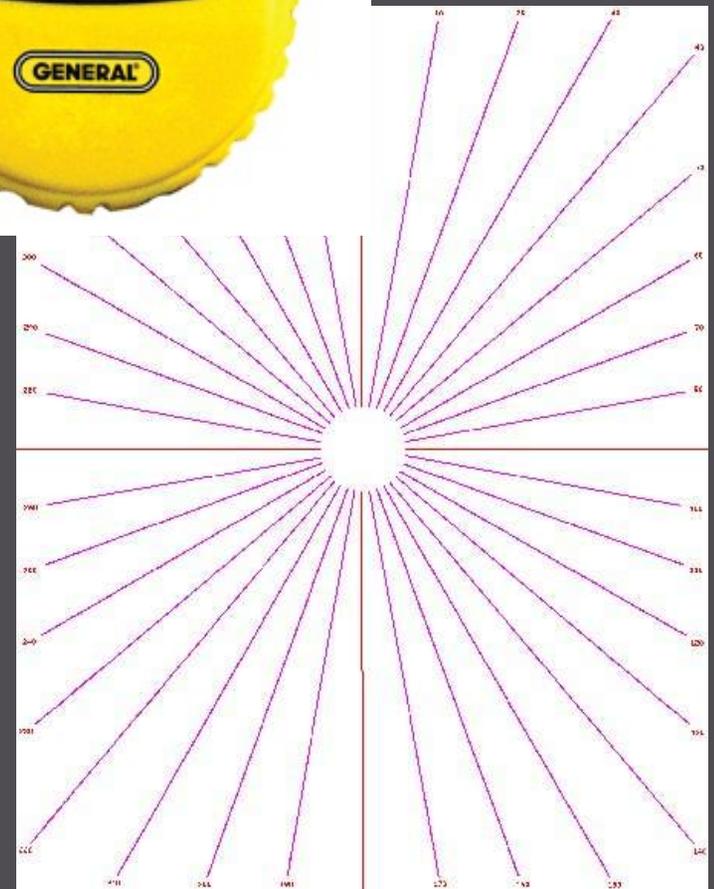
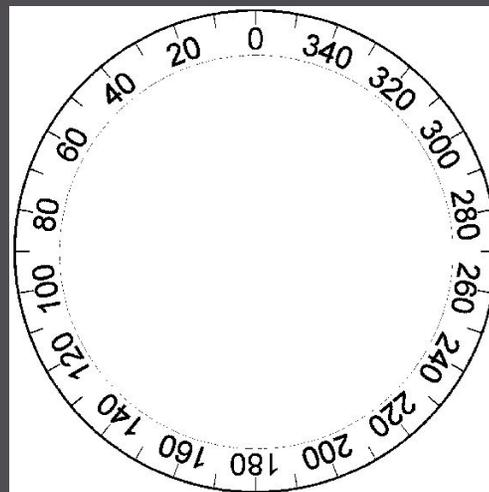
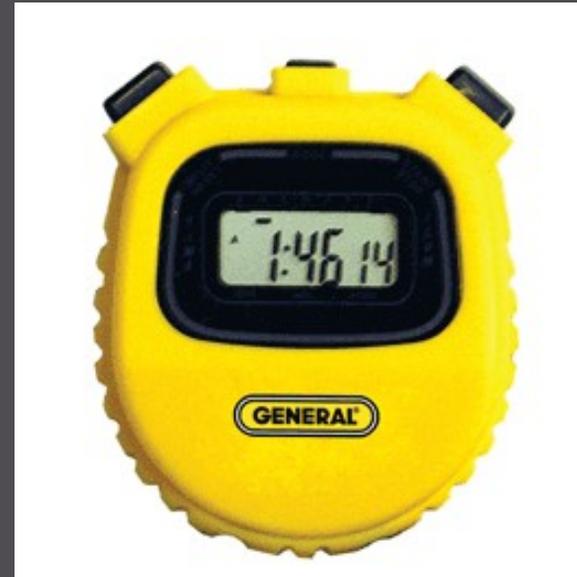
- ▣ Five channel common clocked RTL-SDR
- ▣ Built in noise source
- ▣ Automatic phase synchronization hardware
- ▣ Kraken \$499
- ▣ Five Magnet-Mounted Antennas \$199

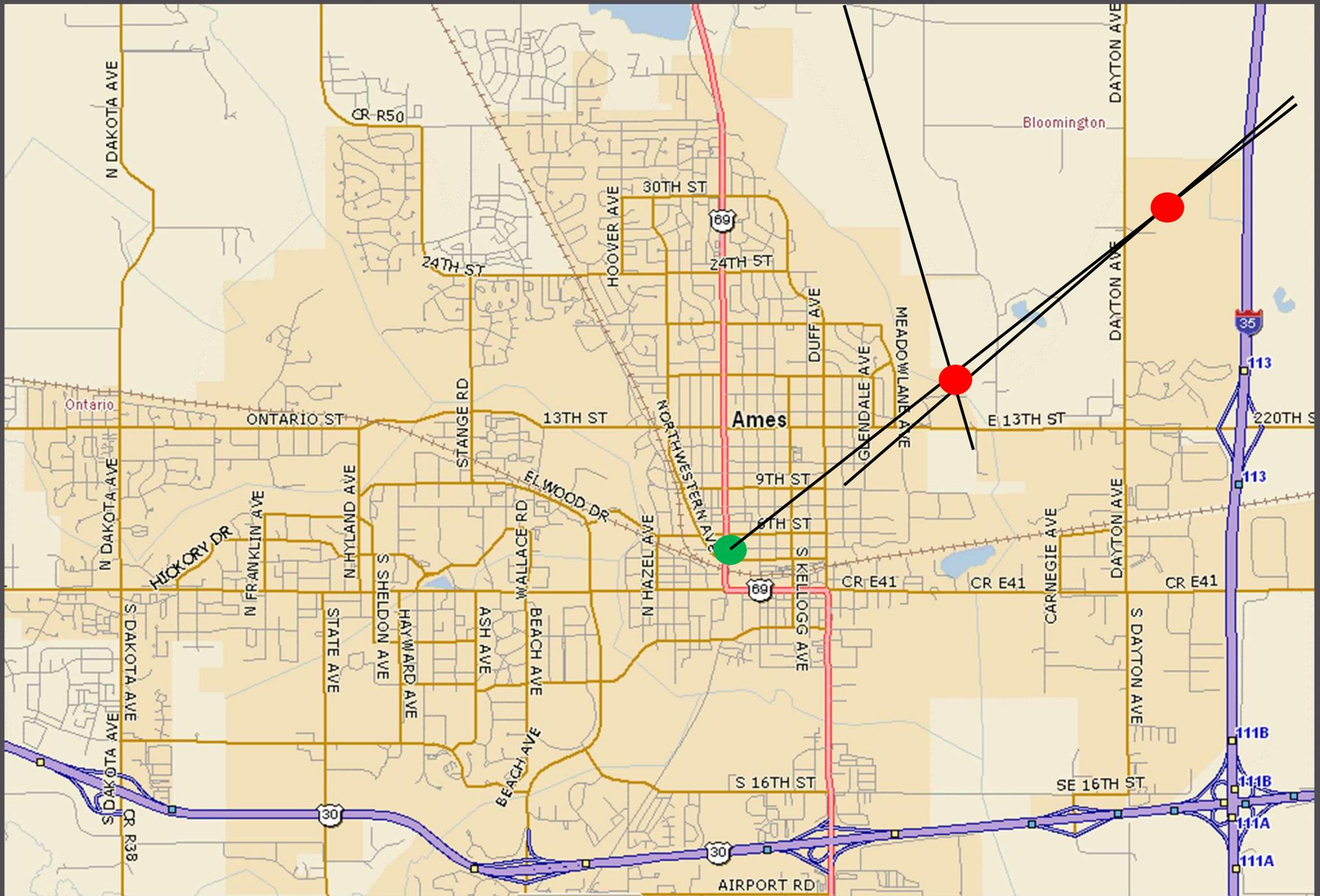


Kraken SDR - 5 Channel Coherent RTL-SDR



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
- ▣ 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)

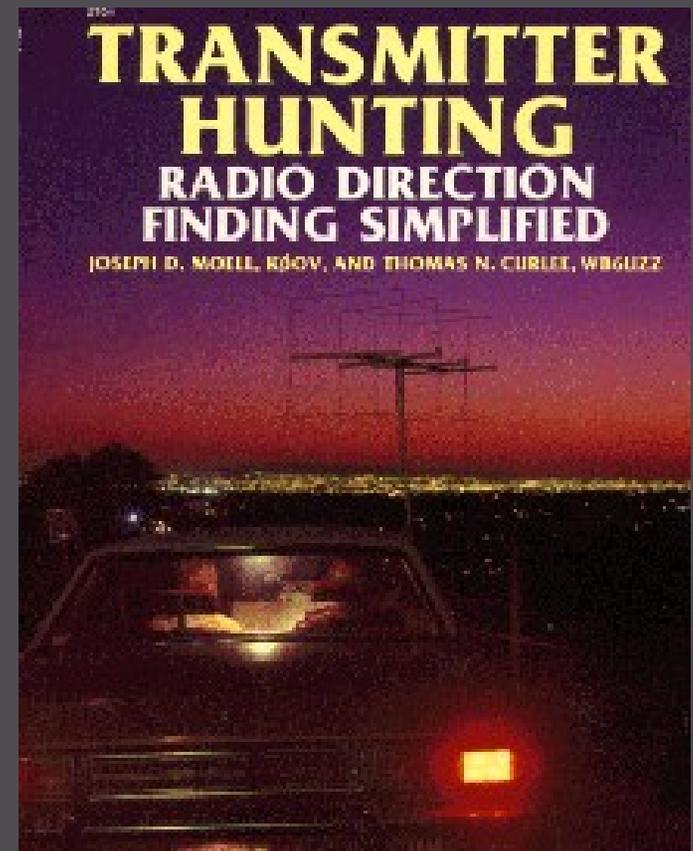
Auxiliary Communications Field Operations Guide (AUXFOG) and National Interoperability

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 15th, 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

