

ICARC Fox Hunting

Presentation by KC0JFQ

Formal Hunt
ICARC FOX (Tx) Equipment
DF (Rx) Equipment
Methodology

http://www.icarc.org/icarc_foxhunt.htm

ICARC Fox Hunting

Classic Competition

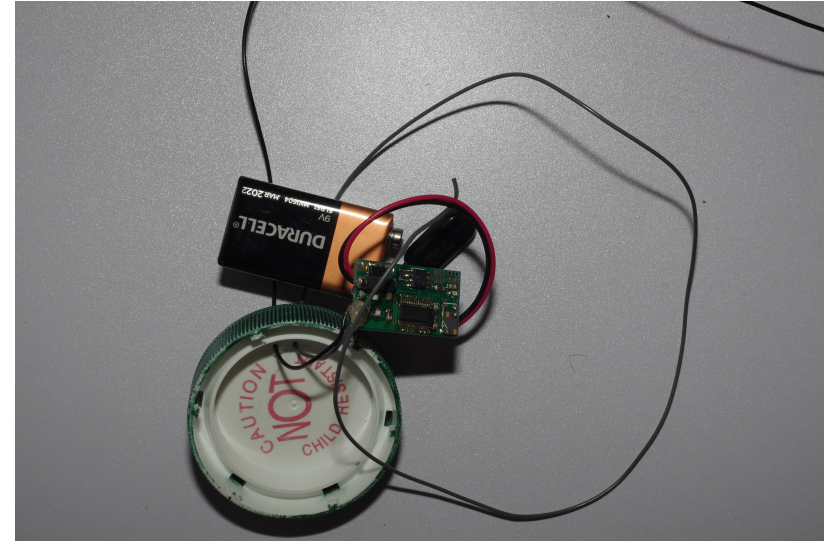
5 transmitters sending CW: **MOE MOI MOS MOH MO5**

5 minute cycle, 1 min. allocated minute for each Tx

Minimum separation 400m (we usually don't follow this)

Time Limit 3 hours (we usually don't follow this either)

Finish Beacon (we usually don't have this)



<http://www.ardf-r2.org/>

<http://www.arrl.org/files/file/ARDF/USA%20ARDF%20Rules%209-Feb-2020.pdf>

ICARC Fox Hunting

Classic Competition

We have enough transmitters to conduct a 5 transmitter event

The 102-73161 transmitters are limited radiated power, typically less than 50mW. This limits area over which we can operate.

New 102-73181 transmitters are 500mW or 1000mW are in software development. This would allow up to move out to Kent Park and cover the entire park. Not enough units currently exist.

http://n952.ooguy.com/eagle/#KC0JFQ_DRA818_TRANSMITTER



ICARC Fox Hunting

Classic Competition

Invite other organizations to participate?

We have always invited UIARC.

Local HAMRAD and law enforcement? (John K0GH: could you manage a handful of RX ONLY radios for non-ham guests?)



ICARC Fox Hunting

ICARC FOX (Tx) Equipment

WB6EYV MicroHunt Foxhunting Transmitter
The Original (we have 3)

102-73161

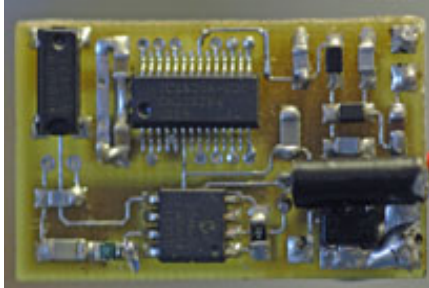
The Original in 3 revisions (we have 8)

102-73176

The first voice capable transmitter (we have 3)

102-73181

The high power transmitter (one software prototype)



ICARC Fox Hunting

ICARC FOX (Tx) Equipment

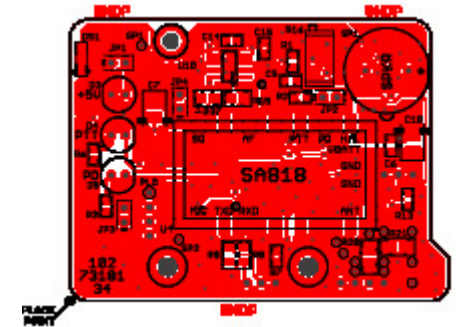
WB6EYV MicroHunt Foxhunting Transmitter

All have to be activated (battery connected) at once to synchronize.
Programmed with club call (W0JV) and MO? Identifier.

102-73161/73176/73181

Fully programmable. These units can operate any schedule you can think of.
TOY Clock allows quick power-on and deploy.
Synchronization is achieved the night before by setting TOY clock to UT.

Newer units have voice capability to allow operators to identify individual transmitters by name.



ICARC Fox Hunting

ICARC FOX (Rx) Equipment

VHF-FM Handi-talkie

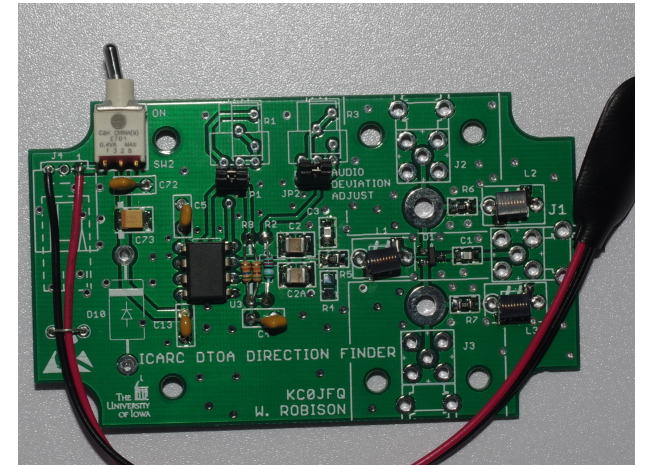
So you can hear the Fox Transmitter.

VHF Antenna

Kinda obvious, yes?

Magnetic Compass and Map of the area

Plot *line-of-position* to transmitter?



ICARC Fox Hunting

ICARC FOX (Rx) Equipment

Body

Use your body as an directional attenuator.

NVARC Fox Finder

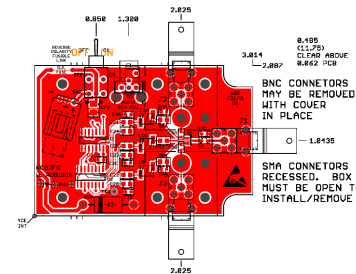
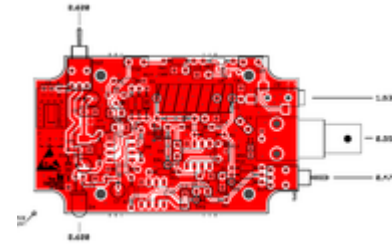
Crude RF detector: <http://n952.ooguy.com/eagle/#NVARC-FOX-FINDER>
Switchable gain.

Yagi

Use directional antenna to establish *line-of-position*.
Don't depend on front/back ratio!
Switchable attenuator to defeat radio AGC

DTOA switch

The elegant solution <http://n952.ooguy.com/eagle/#ICARC DTOA DIRECTION FINDER>
Works with FM only!
Lots of boards on hand!

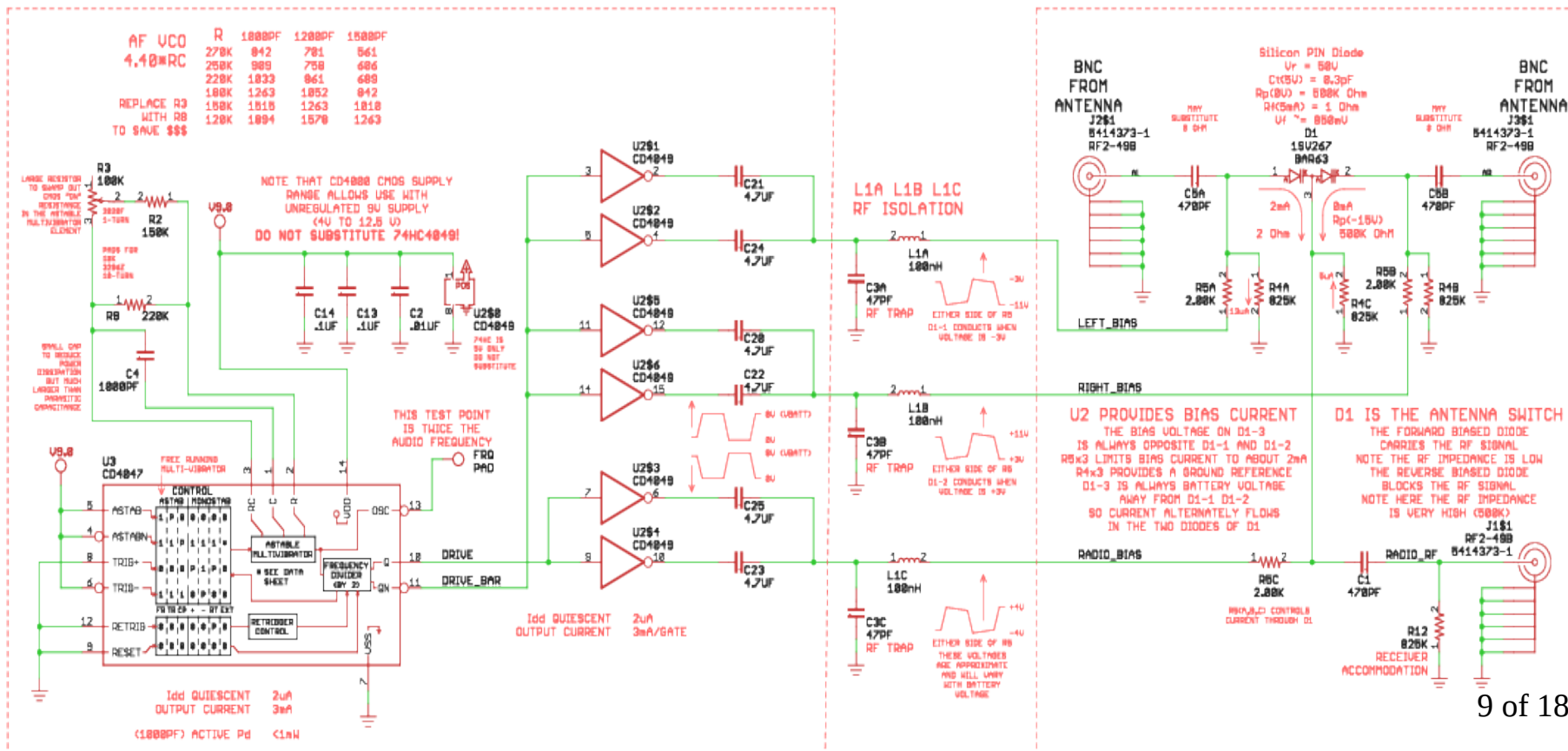


ICARC Fox Hunting

ICARC FOX (Rx) Equipment

DTOA switch

A look at PIN diodes (RF Switch)

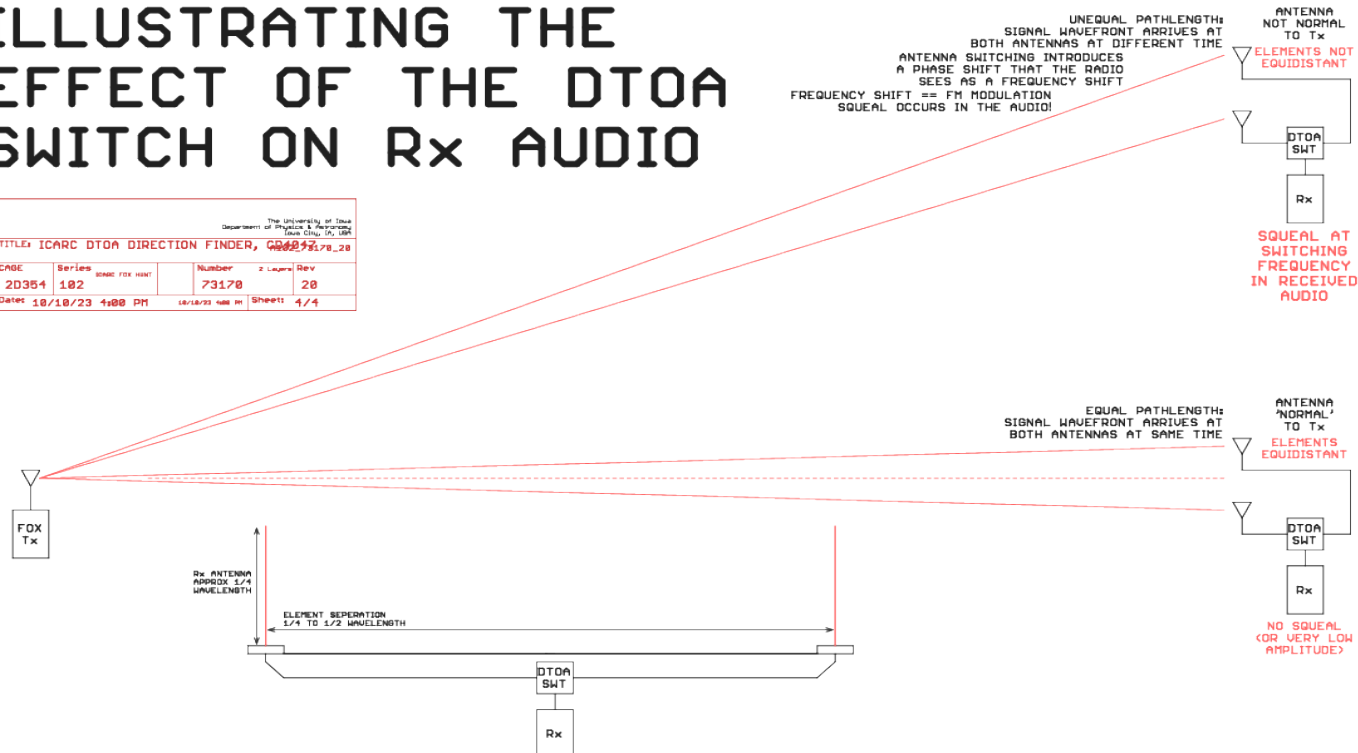


ICARC Fox Hunting

ICARC FOX (Rx) Equipment DTOA switch A look at why/how it works

ILLUSTRATING THE EFFECT OF THE DTOA SWITCH ON Rx AUDIO

The University of Iowa Department of Physics & Astronomy Iowa City, IA 52242				
TITLE: ICARC DTOA DIRECTION FINDER, 000000 73170_20				
CAGE	Series	ICARC FOX HUNT	Number	Rev
20354	102		73170	20
Date:	10/10/23	4:00 PM	10/10/23	4:00 PM
		Sheet:	4/4	



ICARC Fox Hunting

Methodology

Keep your head in the game!
It is very easy to loose track!

Transmitters are only one for **one** minute!
Remember the comment about them being programmable,
they can impersonate each other.

BUT

They are **not** programmed to be deceitful about their identity/callsign.
The audible identifiers (i.e. FOX-five, FOX-seven) are unique and unchanging.

The callsign (W0JV/5 W0JV/7) are also unique and unchanging.

Callsign and identifier are announced at the **beginning** of the message.

Callsign is also at the end of the message to comply with the rules.

CW parameters may change (they probably will change)!

CW chipping rate (i.e. WPM) and the audio tone can change in the middle of a message.

Don't let this lead you down the wrong path.



ICARC Fox Hunting

Methodology

Keep your head in the game!
Use a map to record your line of position!

You'll only get 60 seconds to establish your *line-of-position*.
Walking can take you into and out of multipath,
be aware of metal objects and overhead wires.

When you hear the SK(... -.-)
the transmitter is done so record your *line-of-position*.

The fox transmitter verbally sends **callsign** and the **unit name** (identity).
Battery condition in volts/tenths is then reported first using morse
and then using a simple dah/dit encoding.

The rest of the transmit period is filled with CW or voice traffic.
A carrier is generated continuously throughout the transmitting period.

Radio Transmitter "Fox Hunt" - 27 Apr 2019 - 0900-1100

Aliens have setup secret radio transmitters in Fayette County! We need your help to find them.
<https://kk4gq.org> for details.

Optional Radio Finding "Fox Hunting" Class - 25 Apr 2019 - 1900 - First United Methodist Church of Fayetteville, Room C260

FAYETTE COUNTY
KK4GQ W4JB
Amateur Radio Club
GEORGIA

FOX HUNT

ICARC Fox Hunting

Methodology

Keep your head **and eyes** in the game!
Use a map to record your line of position!

*Your lines-of-position should converge on the transmitter.
(multipath!)*

Currently the fox transmitters all have an orange rubber-ducky antenna that is about 8" long.
It may be sitting behind a tree or other obstruction so as not to be readily visible.

Record the ***event validation code*** and the ***ID*** from the bottom of the transmitter on your score card.

This label is generated with unique identification fields for each fox hunt.
You will also note that this label has the transmitters name.



ICARC Fox Hunting

Methodology

Keep your head in the game!

FOX TRANSMITTER **W0JV/8**
Nickname: FOX8 144.285 MHz 102_73161_25
ID: 025953 Power 5.0mW Ref Xtal:20.000
Valid 7 days from Sat May 6 08:36:48 2023
Iowa City Amateur Radio Club
Hickory Hill Park FOX HUNT
Event Validation Code: 144.150/SF759DJG

ICARC Fox Hunting

Recording your discovery

Paper punches get lost too easily!

FOX TRANSMITTER

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Nickname: FOX8 144.285 MHz 102_73161_25

ID: 025953 Power 5.0mW Ref Xtal:20.000

Valid 7 days from Sat May 6 08:36:48 2023

Iowa City Amateur Radio Club

Hickory Hill Park FOX HUNT

Event Validation Code: 144.150/SF759DJG

ICARC Fox Hunting

Methodology

Practice transmitters!
It is very easy to track these!

Remember I said they are programmable.
We may have one of two channel hogs turned on!

These run on their own frequency transmitting almost 100% of the time.
You may find these useful to familiarize yourself with your equipment.

ICARC Fox Hunting

HF FOX Hunting ?

Our Fox Transmitters can operate in the HF band!

DTOA with AM ?

DTOA with Sideband ?

ICARC Fox Hunting

Happy Hunting

I'm at the end!

ICARC Fox Hunting

Presentation by KC0JFQ

Formal Hunt
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DF (Rx) Equipment
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Here we go again

A short list of “keeping your head in the game”

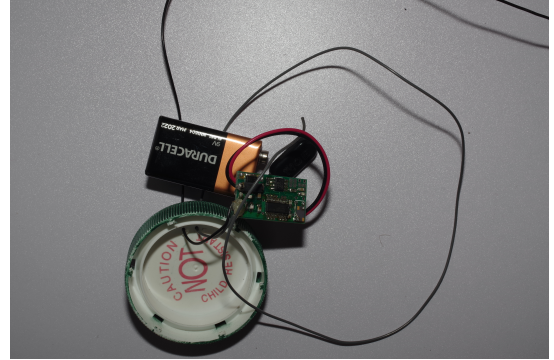
Will try to run through things in this order with a few relevant diversions :-)

This presentation is on the club website (and linked on the fox hunting page).

ICARC Fox Hunting

Classic Competition

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Minimum separation 400m (we usually don't follow this)
Time Limit 3 hours (we usually don't follow this either)
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ARRL defines a 'standard' fox hunt.

Seems this was built in the days when computer resources were more difficult to deal with. Small SOC devices with limited memory. Transmitter control implemented in small memory footprint severely limiting what the transmitter has to say.

i.e. callsign for hosting organization and a 3 character identifier.

Timing controlled by when the battery is plugged in.
Gotta do 'em all at once!

Finish beacon can be configured with resources we have on-hand.

ICARC Fox Hunting

Classic Competition

We have enough transmitters to conduct a 5 transmitter event

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New 102-73181 transmitters are 500mW or 1000mW are in software development. This would allow up to move out to Kent Park and cover the entire park. Not enough units currently exist.

http://n952.ooguy.com/eagle/#KC0JFQ_DRA818_TRANSMITTER



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On the fox transmitter side, we can do better.

Timing controlled by TOY clock (TOY clock set on the day before). Turn it on as it is placed at the event site.

Very low power for small area hunt. Such as Hickory Hill Park.

Medium power (500mW or 1000mW) for larger area like F.W.Kent Park.

All the newer transmitters are voice capable, so they can be identified easily for those that cannot copy CW.

ICARC Fox Hunting

Classic Competition

Invite other organizations to participate?

We have always invited UIARC.



Local HAMRAD and law enforcement? (John K0GH: could you manage a handful of RX ONLY radios for non-ham guests?)

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Once we have more 73181 transmitters (like a full set of 5), we can operate a formal hunt (in a large area like Kent Park).

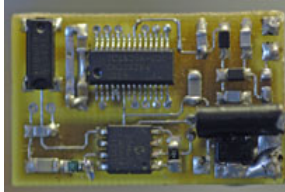
In the meantime, we tend to run small area (Hickory Hill) events.

User radios programmed for the event John ???

ICARC Fox Hunting

ICARC FOX (Tx) Equipment

WB6EYV MicroHunt Foxhunting Transmitter
The Original (we have 3)



102-73161

The Original in 3 revisions (we have 8)

102-73176

The first voice capable transmitter (we have 3)

102-73181

The high power transmitter (one software prototype)



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Our transmitter inventory:

- 1(0) 102-73161-7 This is the original, i.e. the prototype (broken). NO VOICE capability.
- 3 102-73161-12 Adds battery voltage monitor. NO VOICE Capability.
- 4 102-73161-25 Units haywired to accommodate voice! RF amplifier move to daughterboard.
- 3 102-73176 Raspberry-PI units. Power pig! (poor battery life) Adds current monitor.

Under development 102-73181-5 Adds Serial path to RF daughterboard and additional control signal.

ICARC Fox Hunting

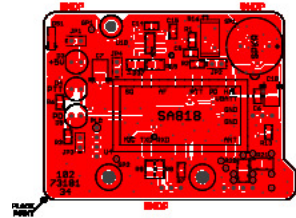
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Fully programmable. These units can operate any schedule you can think of.
TOY Clock allows quick power-on and deploy.
Synchronization is achieved the night before by setting TOY clock to UT.



Newer units have voice capability to allow operators to identify individual transmitters by name.

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WB6EYV transmitters are *micropower* devices. Less than 50mW (probably less than 10mW).

The 73161 boards range up to 50mW. They vary as they use a digital gate for the RF amplifier and 145MHz is at the extreme edge of their capability, Not all gates are *hot enough* to drive at 50mW.

73176 boards also range up to 50mW as they use same RF amplifiers. These are Raspberry-PI based. Power hungry, so I plan to retire them.

73181 boards can use same RF amplifier or the DRA818/SA818 1W transceiver module. Software is in development. Think Kent Park event!

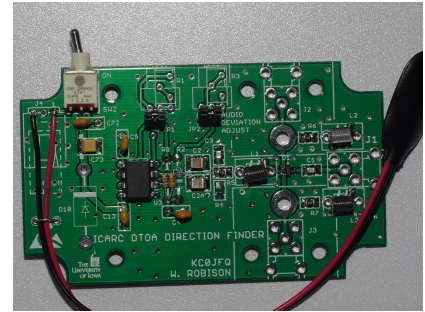
ICARC Fox Hunting

ICARC FOX (Rx) Equipment

VHF-FM Handi-talkie
So you can hear the Fox Transmitter.

VHF Antenna
Kinda obvious, yes?

Magnetic Compass and Map of the area
Plot *line-of-position* to transmitter?



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The modulation scheme is FM. Haven't tried AM or CW, but at 145MHz, who cares (we're all FM there).

Antenna selection becomes important for the close-in events. Even a few mW is substantial when you are close to the transmitter. The nulls in a Yagi pattern can still hear the transmitter very well. Receive AGC gets in the way!

An area map and a compass are vital to track your progress as the transmitter is only on for a minute at a time. Establish line of position (ahead AND behind) when transmitter is on and plot it!

ICARC Fox Hunting

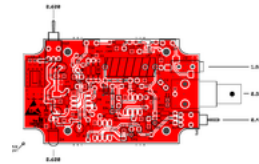
ICARC FOX (Rx) Equipment

Body

Use your body as an directional attenuator.

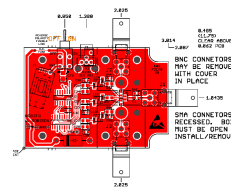
NVARC Fox Finder

Crude RF detector: <http://n952.ooguy.com/eagle/#NVARC-FOX-FINDER>
Switchable gain.



Yagi

Use directional antenna to establish *line-of-position*.
Don't depend on front/back ratio!
Switchable attenuator to defeat radio AGC



DTOA switch

The elegant solution <http://n952.ooguy.com/eagle/#ICARC DTOA DIRECTION FINDER>
Works with FM only!
Lots of boards on hand!

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You are an (minimally) effective RF shield. Receiver close to your chest will shield signal from behind (but not from the side!)

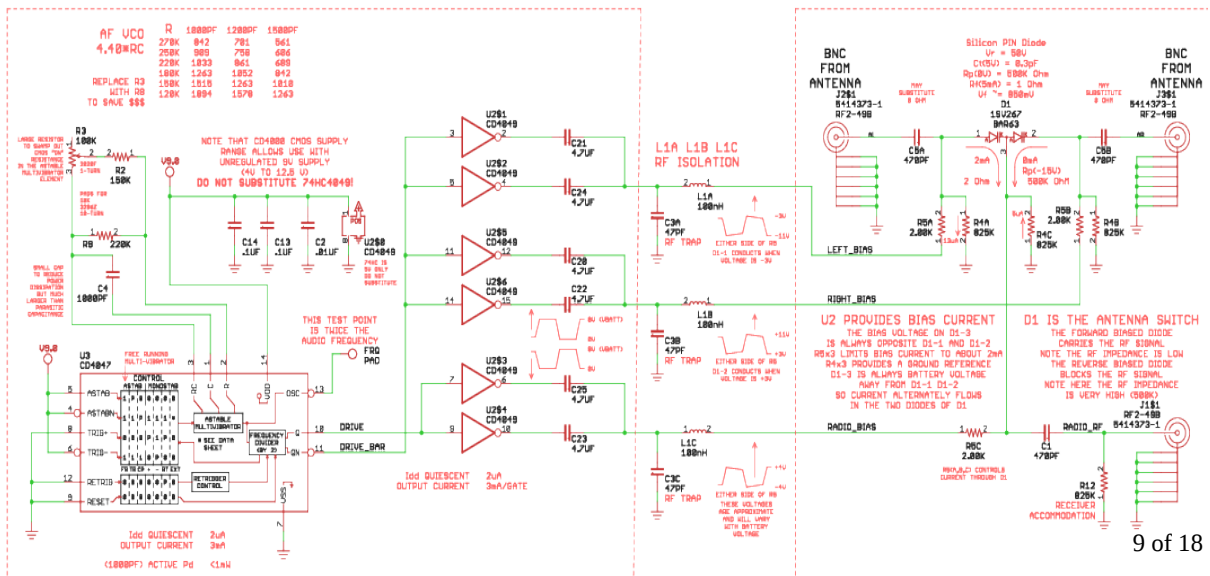
NVARC design is a simple RF detector. Broadband, but probably better than handy-talkie with a Yagi. Selectable gain. (but sucks for concurrent event with more than one set of transmitters).

Yagi is directional, but not so useful when the radio AGC masks signal strength. Step attenuator!

DtoA switch is almost magical :-) Switches between two antennas. Hear Fox Tx when *normal* to source. DtoA switching introduces a *squeal/whine* into the audio from the receiver as the antenna array moves off of normal. Audio amplitude changes with direction. Some direction sensitivity even when DtoA is off.

ICARC Fox Hunting

ICARC FOX (Rx) Equipment DTOA switch A look at PIN diodes (RF Switch)



The “GUTS” of the DTOA switch.

D1 is the PIN Diode, the RF switch.

The switch is DC isolated by the C5A/C5B/C1 caps and the C20-C25 caps. The PIN diodes are kept close to circuit ground by three R4x resistors.

U2 pumps current through the left diode and reverse biases the right diode for on half of the cycle. Current and reverse bias switch on the next half cycle. D1, the PIN diode, is high impedance and low capacitance when reverse biased. Low capacitance and low impedance when forward biased.

U2 provide drive current and operates at 9V, ancient B-series CMOS from the 1970’s!

U3 is the oscillator which provides a nice square output switching control signal.

ICARC Fox Hunting

ICARC FOX (Rx) Equipment DTOA switch A look at why/how it works

ILLUSTRATING THE EFFECT OF THE DTOA SWITCH ON R_x AUDIO

DATE	REV	ISSUED FOR	NUMBER	BY	DATE
2020/4	1.00		735/PB	2.00	
DATE	18/10/23	4:00 PM			

TITLE: ICARC DTOA DIRECTION FINDER, Q00092.00_28

DATE: 18/10/23 4:00 PM

NUMBER: 735/PB

BY: 2.00

DATE: 18/10/23 4:00 PM

NUMBER: 735/PB

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BY: 2.00

UNEQUAL PATHLENGTHS
SIGNAL WAVEFRONT ARRIVES AT
BOTH ANTENNAS AT DIFFERENT TIME
ANTENNA SWITCHING INTRODUCES
A PHASE SHIFT THAT THE RADIO
SEES AS A FREQUENCY SHIFT
FREQUENCY SHIFT = FM MODULATION
EQUAL OCCURS IN THE AUDIO

ANTENNA
NOT NORMAL
TO TX
ELEMENTS NOT
EQUIDISTANT

DTOA
SWT

Rx

SQUEAL AT
SWITCHING
FREQUENCY
IN RECEIVED
AUDIO

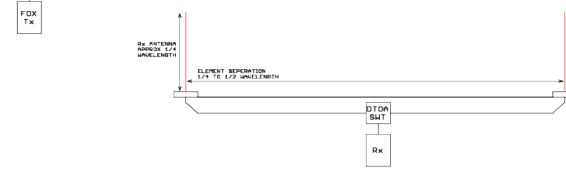
EQUAL PATHLENGTHS
SIGNAL WAVEFRONT ARRIVES AT
BOTH ANTENNAS AT SAME TIME

ANTENNA
"NORMAL"
TO TX
ELEMENTS
EQUIDISTANT

DTOA
SWT

Rx

NO SQUEAL
OR VERY LOW
AMPLITUDE



The “why” of the switch.

Consider the receive antenna array oriented **normal** to the transmitter. Both elements see the same wavefront, i.e. the same thing without any delays. The FM demodulator does its thing the same as if it were connected to a single antenna.

Now we swing the antenna “boom” to the side. The antenna is no longer **normal** to the transmitter so one element sees a slight delay in the wavefront, that is a slight delay. Switch between the elements and that delay looks suspiciously like frequency modulation to the FM demodulator in the receiver.

The switch will introduce noise that you would hear as a low amplitude whine. Switch the antenna boom back & forth to find the **null** and you have your line of position.

ICARC Fox Hunting

Methodology

Keep your head in the game!
It is very easy to loose track!

Transmitters are only one for **one** minute!
Remember the comment about them being programmable,
they can impersonate each other.

BUT

They are **not** programmed to be deceitful about their identity/callsign.
The audible identifiers (i.e. FOX-five, FOX-seven) are unique and unchanging.
The callsign (W0JV/5 W0JV/7) are also unique and unchanging.
Callsign and identifier are announced at the **beginning** of the message.
Callsign is also at the end of the message to comply with the rules.

CW parameters may change (they probably will change)!
CW chipping rate (i.e. WPM) and the audio tone can change in the middle of a message.
Don't let this lead you down the wrong path.



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Take notes of what you see/hear during the transmitter on-time (map!). Time is short!

The ICARC transmitters must comply with FCC identification rules. They are not deceitful in that respect.

BUT. They are programmable. Everything about them is programmable. Audio pitch, CW chipping speed, they can talk. They can be programmed to sound different each time they come on!

Power Output for the DRA818/SA818 module is pin selectable, **but**, there are no plans to allow that to change as the extra 500mW affects battery life significantly.

IMAGE: Using the vehicle body as a directional attenuator.

ICARC Fox Hunting

Methodology

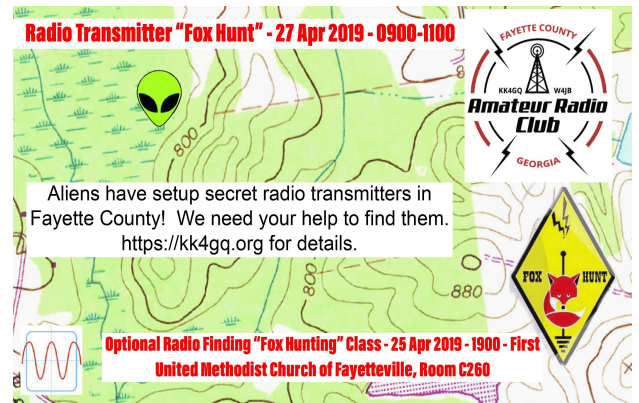
Keep your head in the game!
Use a map to record your line of position!

You'll only get 60 seconds to establish your *line-of-position*.
Walking can take you into and out of multipath,
be aware of metal objects and overhead wires.

When you hear the SK(... -.-)
the transmitter is done so record your *line-of-position*.

The fox transmitter verbally sends **callsign** and the **unit name** (identity).
Battery condition in volts/tenths is then reported first using morse
and then using a simple dah/dit encoding.

The rest of the transmit period is filled with CW or voice traffic.
A carrier is generated continuously throughout the transmitting period.



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As mentioned, you will find plotting a *line of position* on a map a useful method to keep track of your observations. Note that this *line of position* extends in front of you as well as behind you. Yagi has gain in both front and behind direction.

You should get to the point that you recognize the **CQ CQ CQ** announcement at the beginning of the message as well as the **SK SK SK** at the end. CQ is easy, the SK is useful to let you know when it's time to mark your observation on your map.

ICARC Fox Hunting

Methodology

Keep your head **and eyes** in the game!
Use a map to record your line of position!

*Your lines-of-position should converge on the transmitter.
(multipath!)*



Currently the fox transmitters all have an orange rubber-ducky antenna that is about 8" long.
It may be sitting behind a tree or other obstruction so as not to be readily visible.

Record the **event validation code** and the **ID** from the bottom of the transmitter on your
score card.

This label is generated with unique identification fields for each fox hunt.
You will also note that this label has the transmitters name.

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As you cycle through several time, you *LOPs* should start to converge on the transmitter location.

Note the obnoxious orange antenna on the ICARC transmitters. I have to be able to pick them up at the end, so you can look for the out-of-place color when you get close. They might be in a not-so-obvious place, but I hat to see them when the hunt is over.

The Fox Transmitter should be positioned so you can easily read the validation code. That code is regenerated for each hunt so it will be unique for each hunt. Simply record it on you log card. Both codes on the transmitter are unique. Either one is acceptable.

The transmitters name is also visible on the label with the validation code. This name should match the outgoing message.

ICARC Fox Hunting

Methodology

Keep your head in the game!

FOX TRANSMITTER **W0JV/8**
Nickname: FOX8 144.285 MHz 102_73161_25
ID: 025953 Power 5.0mW Ref Xtal:20.000
Valid 7 days from Sat May 6 08:36:48 2023
Iowa City Amateur Radio Club
Hickory Hill Park FOX HUNT
Event Validation Code: 144.150/SF759DJG

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Sample Label

In the upper right is the callsign that the Fox Transmitter sends (FCC identification).

The *Nickname* may be vocalized by the transmitter. You'll notice that the numeric part matches the Callsign suffix.

The **ID:** field is generated just before the labels are printed, as is the **Validation Code**.

The 144.150 in the **Validation Code** field is the frequency on which the Fox Transmitter sends its startup message. This is used when setting the transmitters out in the field (all transmitters used in the event use the same startup frequency).

You shouldn't need to pick up the transmitter or disturb it.

ICARC Fox Hunting

Recording your discovery

Paper punches get lost too easily!

FOX TRANSMITTER **W0JV/8**
Nickname: FOX8 144.285 MHz 102_73161_25
ID: 025953 Power 5.0mW Ref Xtal:20.000
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Iowa City Amateur Radio Club
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W3ACO found a set of punches when we first started. Setting them up was just more detail that has to be fussed with as more Fox Transmitters come on-line.

Hence the **ID** field and the **Event Validation Code** on the label. They are both generated when the labels are printed a day or two prior to the event. They are as random as the random number generator on Linux. (New labels for each event).

Note that the **Event Validation Code** has the unit power-on identification frequency. When the units are turned on as they are set out, they broadcast on this frequency so the organizer can hear that they are operational. This is a side-effect of running a multi-frequency hunt.

ICARC Fox Hunting

Methodology

Practice transmitters!
It is very easy to track these!

Remember I said they are programmable.
We may have one of two channel hogs turned on!

These run on their own frequency transmitting almost 100% of the time.
You may find these useful to familiarize yourself with your equipment.

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We also have plans to setup a few of the oldest transmitters to transmit almost continuously.

If this is your first event (or if you want to familiarize yourself with your equipment), this should provide a means to figure out how your equipment works without things shutting down 58 seconds after you start :-)

They operate on their own frequency so they don't interfere with the formal hunt.

These older transmitters probably lack audio capability, so they're strictly CW.

ICARC Fox Hunting

HF FOX Hunting ?

Our Fox Transmitters can operate in the HF band!

DTOA with AM ?

DTOA with Sideband ?

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The clock synthesizer is much happier in the HF band!
Should get 50+mW from the 74LVC04 amplifier. Is there room for the low-pass filter? Probably OK at 50MHz.

DTOA with AM? The antenna switch expects the radio to have an FM demodulator used as the direction finding element. Use FM detector to listen for the squeal! Should be quite interesting

DTOA with Sideband?

All of the Fox Transmitter boards have the capability to control an external radio. PTT and Audio are all that is required. The 102-73181-5 boards have connections for serial control as well.

ICARC Fox Hunting

Happy Hunting

I'm at the end!