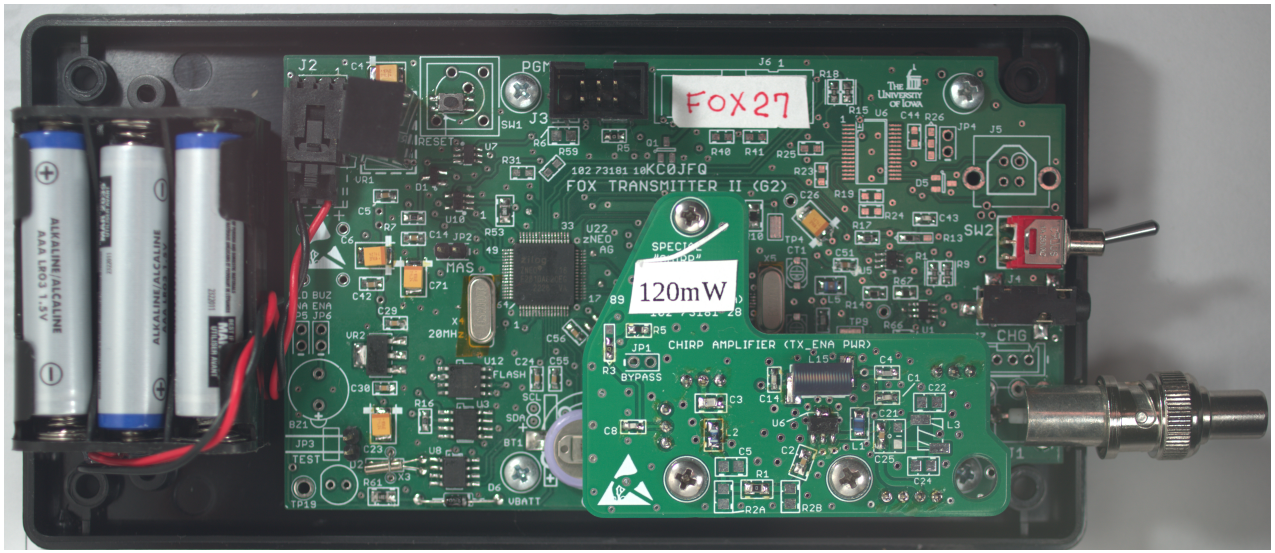


# The ICARC FOX Transmitter

## High Function Transmitter System

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Job: fox˙present˙7
File: fox˙present˙7.tex

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Iowa City Amateur Radio Club

# Outline



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# Capabilities

Broad Overview of the features provided in this **Fox Transmitter System**

- Self Contained Fox Transmitter All living in a 6.7 x 3.4 x 1.4 enclosure
  - Highly Programmable Uses a *System Control Language (plain text)*
  - Synchronous Operation Uses a *TOY* clock (Time Of Year)
  - Transmitter Controller Will also control an external tranceiver
    - PTT Open Drain
    - Audio Tone and Voice, line level
    - Serial Control 3.3V CMOS levels
  - Battery Power 7 Volts to 24 Volts
    - 6 AAA internal Low cost alkaline cells
  - Low Power
    - Around 100 Milliwatt Simple RF Amplifier
    - Up to 1 Watt RF Module SA818/DRA818
  - Simple Programming Hardware
    - Serial Cable (USB to serial from FTDIchip)

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# Simple Programming Hardware

Configure the unit using a serial cable (56Kb/s)

- 3.3V CMOS Logic levels (not RS232)

FTDIchip TTL-232R-3V3-AJ DigiKey approx. $25.00

- Driver Availability
  - Windows Provided with later versions
  - Linux Provided with all kernel versions since V3.x

Physical Intereface 3.5mm (1/8") TRS jack

- TIP/RING are data (bidirectional)
- SLEEVE is ground
- Bit Rate is 57,600 bits/sec
  - Can be commanded to 115,200 bits/sec for high speed loading
- Loading audio files is slooooooooooooooooooooow

# Power

## Battery power and RF power

### Battery

- Run several hunts on a battery Typically 20 hours
  - Idle Current Typically less than 50mA
  - Active Current Typically less than 150mA

### RF

- Barefoot less than 5mW
  - RF generator direct to antenna **NO** amplifier
- RF Amplifier 30mW to 250mW
  - Several designs in use (MMIC IF Amplifier)
- RF Module 250mW to 1000mW
  - SA818/DRA818 tranceiver module (eBay)
- External Tranceiver handie talkie
  - Power determined by the tranceiver

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# Battery

Operate from a wide rane of supply voltages.

- Alkaline battery easy replacement *no charging required*
  - Internal pack 6 AAA cells In 3x2 holder
    - This configuration gives 20+ hours of operation
  - External pack 6 to 12 AA cells primary or secondary cells
    - Larger cells or packs up to 24V
    - Not limited to alkaline (but alkaline cells are cheap!)
  - External Supply Bench Testing
- H.T. power
  - Connector for H.T. has pin for routing power **into** the Fox Transmitter
    - Electrically bidirectional
      - Internal battery not capable of sufficient current for external transmitter

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# Handie Talkie Controller

The *Fox Transmitter* may also function as an external tranceiver controller.

- **PTT and Audio** basic control required for all applications
  - 14-pin header signals (for H.T. Interface)
    - PTT Open Drain Push-to-Talk
    - DEV Audio Deviation (nominally line-level)
    - TxD/RxD Serial Control (3.3V CMOS levels)
    - VBATT Direct connection to battery
    - SWITCH Switch Closure detection circuit
    - PHOTO_CELL Photo-Cell detection circuit
- **Frequency Control is, of course, H.T. specific**
  - Can be added to program code
    - Requires RE-Flash of SOC
    - RE-Flash requires hardware programmer and software

# Synchronous Operation

## Coordination of a multi-unit hunt group

Schedule arbitrary number of transmitters on a regular repeat cycle

- **TOY Clock** ALL units running with same *idea* of time
- **Time is kept as a simple 32 bit integer** Seconds from midnight
- **MODULAR Arithmetic** divide and use the remainder (ignore quotient)
  - Run when **Offset** == **System_Time** % **Period**
  - All **System_Time**s are the same (TOY clock)
  - All **Period**s are the same Operating program in FRAM
  - Each **Offset** is unique Operating program in FRAM
- **Example Hunt Group Scheduling Settings** (for a 5 unit group)
  - FOX1 schedule: **MODS 300,0**
  - FOX2 schedule: **MODS 300,60**
  - FOX3 schedule: **MODS 300,120**
  - FOX4 schedule: **MODS 300,180**
  - FOX5 schedule: **MODS 300,240**

Each unit has about 55 to 60 seconds to transmit.

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# Programmable

## Operating *program* stored in FRAM

At least 256 program steps (or commands) (supports larger devices)

Each command is stored in a 32 byte record (minimum FRAM size 64Kb)

### Configuration Commands

Define identity of the transmitter

**CALL** Define Callsign

**NAME** Define Nickname

Define hardware configuration

**CONF** Define RF subsystem

Define schedule

**MODS** Define scheduling parameters

### Messaging Commands

Station Identification

**BEGN** command Turn on RF and send callsign in code

**DONE** command Send callsign in code at end (FCC rules) and turn off RF

Message Traffic

**CODE** command Send code message traffic

**TALK** command Send **voice** message traffic

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# Personality

What behavior can we implement?

- Formal FOX hunt looks like the Byonics or WB6EYV
  - CQ CQ CQ de W0JV MOE MOE MOE MOE . . .
  - de W0JV SK SK SK Always identify at the end!
- ICARC FOX hunt
  - CQ CQ CQ de W0JV *verbalize* Callsign and Nickname.
  - Code message traffic *fill up the 60 second window*
  - de W0JV SK SK SK Always identify at the end!
- Wildlife tracker FOX hunt
  - CQ CQ CQ de W0JV *code the* Nickname.
  - CHiRP*ing* **interrupted carrier** tone bursts *fill up our 60 second window*
  - de W0JV SK SK SK Always identify at the end!
- All talking FOX hunt looks like the Byonics or WB6EYV
  - CQ CQ CQ de W0JV
  - Verbalize Callsign and Nickname all the message traffic
- Anything you can think of...
  - The transmitter *personality* is stored in FRAM

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# Hunt Setup

What is done to prepare for a hunt (the night before)

- Set TOY clocks Get all transmitters operating on the same page!
  - Battery voltage check by-product of clock setting utility
- Replace Batteries When something complains that they're low
  - Clock setting utility reports on battery condition
- Format and Print hunt documents (Some parts are serialized)
  - Hunt labels for transmitters unit-specific serial number
  - *Transmitter Found* cards unit-specific serial number
  - Transmitter Check Sheet Condition report, unit serial numbers
  - Any other hunt-related materials not serialized
    - Unserialized material can carry over from one hunt to the next
- Don't forget pens, pencils, handie-talkie!

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# Hunt Setup (site)

## Setup at the site

### Don't forget the transmitters and supplies!

### Transmitter dispersal

- A Handie-talkie set to setup frequency (I use 144.150MHz)
- Area map so you can find them at the end! GPS if area is open
- Drop one hunt group at a time *five or six transmitters*
  - At your **spot** turn transmitter on Listen for sign-on message
  - Mark your **spot** on the map (You'll thank me later :-)
  - Rinse & Repeat Set the whole group ot and go back for more
- Error Recovery *OOPS, you bumped the power switch*
  - Just turn it back ON! The TOY clock synchronizes them!!! *no harm, no foul*

### Tear-Down

- Go collect your transmitters *The MAP!, The MAP!*
  - No turn-off restrictions, just switch it off...

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# Frame Title

Top Level (we're done!)

- Indent 1 Extra *text*
  - Indent 2 Extra *text*
    - Indent 3 Extra *text*
    - Indent 3 Extra *text*
  - Indent 2 Extra *text*
    - Indent 3 Extra *text*
- Indent 1 Extra *text*

# Scary Notes for the Presenter

These are my crib notes. I sure hop I rememberd to print them off and bring them along...

## Capabilities

The first hunt we did, back about 5 years ago, made use of a simple transmitter. Just an 8-pin PIC processor and the vererable/detestable ICS525.

Had to plugh 'em all in at the same time as you're dropping them in the field. They're also so damn small you have to flag them or you'd have a hard time recovering them at the end of the hunt. Poor hunter wouldn't have a change.

How 'bout something that's small, but not too small. Something that you can mount an obnoxious orange antenna on. Something you as the hunt organizer, can find when it's all over.

Although we don't plan on using an external transmitter (i.e. hand-held tranceiver), the control interface to the fox transmitter RF subsystem is the same needed by a handlheld. We get that control for the proce of a single connector (whihc we don't eben need to populate).

# Simple Programming Hardware

I don't want to deal with a ZiLOG programmer when loading sequences and waveforms into the fox transmitter. If you are setting up a hunt, you wouldn't either.

USB Serial cables are easy, it's about the only way you can do serial these days. If exclusively use FTDIchip hardware to avoid Windows problems. Anyone trying to get a Japanese HF radio USB connection working will probably understand.

Anyone trying to get a Japanese HF radio USB connection working will probably understand.

The audio CODEC pops right up, but if you do anything in the wrong order, the CP2102 driver pukes and you're going to spend the next few hours fighting it.

Unless it's a counterfit chip, then you're hosed.

FTDIchip parts don't seem to be so sensitive, but I use Linux exclusively, so all this serial stuff just works.

# Power

AAA batteries are Costso or from Amazon are less that 2 bits (a quarter, 25 cents). I can replace the set for a buck-and-a-half with AAAs. LR9 can be had for the same or a bit more, but they won't last as long and may not supply enough current for target RF output levels.

The fox transmitter monitors battery current and can self-perform a battery performance analysis. Well, at least it can collect data on itself when operating.

The RF side, we can use RF amplifier modules to target the *needs of the day*.

Barefoot,we see less than 5mW, a real QRP hunt! Maybe even operation using the LR9

Other RF amplifiers give us from about 50mW up to around 1000mW.

We can tailor our selection to meet battery constraints or to provide broader coverage.

# Battery

The first designs used a simple linear regualtor. Not too expensive and effective.

Battery life can be extended with a more efficient design. Running with a higher pack voltage may allow extracting a bit more life out of a disposable cell.

The 6 AA pack fits inside the enclosure making for convenient portable operation. Cart the transmitters out to the site, plant them and we're ready to hunt.

Through the use of a switch-mode power converter we can use higher voltage packs, of move to a rechargeable type of battery that operates at a higher voltage.

The power converter family that mechanically fits on the main board all deal with voltages up to at least 24V. 8 and 10 cell packs can be attached to the fox transmitter is extended time is required or to delal with higher power RF sections.

When the system is configured as a conroller for an external RF system, the external system can supply power through the connector that connects to the external device.

# Handie Talkie Controller

There is a 14-pin connector that provides connection to an external radio. All the available connections are listed on the slide.

Even a few you probably didn't even want, like the switch and photocell lines.

# Handie Talkie Controller: Software

Taking note that the external *Handy Talkie* interface provides serial data, the vast range of hand-held and mobile units might suggest the software in the fox transmitter system probably doesn't have any external device control implemented.

That impression would, in fact, be accurate. There is not much space left in the zNEO program flash to implement much. Of interest would be simple frequency control to allow an external radio to behave much like any of the other transmitters in that it would transmit a sign-on message on a common frequency and then shift to an operating frequency.

Basic operation does not require any unique software in the fox transmitter. If you set the operating frequency and attach the fox transmitter as a controller, it will happily mash the transmit key (i.e. the PTT line) and send audio traffic. The audio traffic being a CW message or something from the audi file system.

# Synchronous Operation

Modular Arithemtic

The arithmetic of remainders

The **clock** (i.e. the TOY clock, a DS1672 clock chip) is the magick that allows all these transmitters to operate in a cooperative manner.

The timing methodology is based on usgin the time from the TOY clock to derive **seconds from midnight**. TOY clock can be loaded with any conveniently truncated time, as long as everyone is loaded from the same source. As far as scheduling is concerned, time=10, time=86410, time=259210 are all the same.

First step, then, is to calculate time of day by taking system time modulus 86,400 seconds. That is take system time, divide by 86400, and keep the remainder.

Now we have seconds from midnight.

Everyone in the hunt group **must** use the same period.

Everyone in the hunt group **must** use a unique offset.

In the calculation, the % indicates division where we keep the remainder, not the quotient.

Everyone in the hunt group (well, all our fox transmitters that are out for the hunt) will get the same result from that **System Time % Period** calculation.

Sine we **must** be running with unique offsets, only one unit in the hunt group will mact the offset value with the calculation. That guy that matches get to run!

You might also take not that the offsets **must** also be properly spaced. In most cases they will be evenly spaced, but once you get a firm grip on the scheduling methodology you can play some interesting games with the hunters.

# Programmable

Without the FRAM loaded, the fox transmitter is utterly helpless. Every about the transmitter is configured through commanding.

These commands live in the FRAM. Some are run when you flip the power on and some are run when a scheduling point occurs.

Since everything is configured by command sin FRAM, There is almost nothing about the transmitter stored in the zNEO program flash.

The zNEO 128KB program flash is far too small to hold commands or audio data, so nothing lives there.

As suggested, you must congiure the identity of the fox transmitter before operating as a real-live fox. It should also be obvious you must set the hardware configuration before you can actually send RF out.

The scheduling commands were casually described on the previous page. Simply note that there can be up to 10 schedules defined with any number of them being active where active simply indicates the scheduler will run them when their define scheduling point occurs.

Scheduling is strictly single threaded. If you define overlapping schedules, once a sequence is running it runs to completion and any additional scheduling activity doesn't occur.

Message traffic (over-the-air traffic) is generated as a result of the messaging commands as generally indicated on the slide.

The **BEGN** and **DONE** command handle turning the RF subsystem on and keying it followed by sending an identification message. The **BEGN** identification message is **e CQ CQ CQ de <CALL>**. The **DONE** identification message is **de <CALL> SK SK SK**.

**CODE** runs the Morse code generator, transcribing the text in the command into code and sending it. The filesystem in FRAM is composed of fixed length records so the amount of text is quite limited. This isn't a problem as you can have as many **CODE** commands as you need to store the message.

**TALK** runs data from the FLASH file system through the DAC to generate audio. The FLASH file system is composed of RIFF/WAVE files that each contain a fixed amount of audio data. You are free to store short utterances of a full sen tence in an audio file. When the **TALK** command calls out a file (by name) to run, a directory look is performed to determine the starting point of the file. The file has all the remaing information required to send it out.

# Personality

You get to describe the fox transmitter personality through the commands stored in the FRAM. It may be verbose, all talking other than the signon and signoff messages.

It may be all in code if that is what you desire.

The operation, other than it must start with **BEGN** and end with **DONE**, is entirely determined by the commands you load.

The transmitter has the capability to **frequency hop**, Not frequency hopping like a modern ingterference avoiding radio, rather it can change frequency by issuing a **FREQ** command.

It will not change in the between the **BEGN** and **DONE** commands, but the frequency can be different for every message.

Code parameteers **can** change at any time. The code parameters are immediately updated when the **CWPM** or **TONE** commands are encounteered.

Most of the ICARC message sequences run the **BEGN** and **DONE** messages with an audio frequency and word rate different from the body of the message.

When you hear the audio frequency change, it's an indication the message traffic is about to end.

# Hunt Setup

I want to be able to sti back and watch thehunt unfold before me. I want to avoid as much work at the hunt as I can.

Much of the work occurs the night before the hunt when the transmitters are all quickly tested and their clocks are all updated. During the clokc update process, the battery state is recorded and any units that need new batteries are flagged.

A set of print files are generated from the battery data collected from the clock setting activity and printed for the hunt. We generate several serialized print files and several generic print files.

The serialized print files are generated with unique serial number. These serial numbers are generated in the print formatting utility and **will** change if the formatting utility is run again. The serialized files include:

The serialized files include:

- Transmitter Status check sheet
- Transmitter Fox Hunt label
- Transmitter Fox Hunt FOUND cards

Other files are **not** serialized and may be saved from one hunt to the next.

# Hunt Setup: Site Setup

After setting up my checkin station and hiding the transmitter checking sheet that has the serial numbers for each transmitter, I can begin hiding transmitters.

Take a hand-held GPS along if you're not too deep under the tree cover, to mark you hiding spots. I forget at least one or two hiding spots and have to direction-find them after the hunt. A paper map would slo work for this.

Set you hand-held, remember the one you should have for the hunt, to 144.150MHz to monitor as you set them out. All of the 102-73181 units have seperate audio memory (i.e. a large-ass FLASH) and can verbalize a battery report. If you have a unit where the battery has crashed, this is your last chance to avoid having a transmitter crash in the middle of the hunt.

A crashed transmitter, in this context, is at most embarassing. If you've marked it with a GPS or on the map you can go and collect at the end. The memory devices shouldn't suffer from unstable operation.

A crashed transmitter, however, has a battery leak just waiting to happen. Open the box and remove the batteries to prevent damage from leakage. The TOY clock battery will run off the internal backup battery just fine.

# Hunt Setup: Signin

Collect Names

Distribute frequency list.

## Hunt Setup: Hunt

Timestamp when they start

Turn 'en loose, send 'em out.

For a very formal hunt, we may have the transmitters configured to remain silent until the hunt starts. Yes, there are commands to configure this bahavior.

Needless to say you can't monitor transmitters after they send their sign-on message, but neither can the hunters.

## Hunt Setup: Collecting Hunters

Timestamp when they return.

## Hunt Setup: Site Teardown

Go get the fox transmitters.