Introduction
Hello my name is Kevin, Callsign MW0KXN. I am delighted to be invited back after last year's SOTA presentation.

The Rooster is a wonderful little radio. Whilst preparing this presentation I have come to appreciate this radio more and more.

Overview of presentation
The following 13 slides cover:

- The ancestry of the Rooster
- The Rooster Specification
- The Rooster receiver
- Directs Conversion Receivers and Image frequency
- Bandwidth
- Crystal Oscillators
- QRP

After which we will attempt a demonstration of the Rooster on air.

Rooster Ancestry

Summer 1983 - FOXX,

George Burt GM3OXX (SK) published a design for an elegantly simple QRP transceiver called the FOXX in SPRAT, the journal of the G-QRP Club.

The FOXX has just five transistors, employing the PA transistor as the detector for the receiver.

Spring 1999 – FOXX-3

Derek Alexander G4GVM published the design of the FOXX-3 in SPRAT.

The FOXX-3 provided a few refinements making operation easier, but still employed the PA transistor as the detector.

Autumn 2023 - Rooster

Paul Webb M0BMN at Kanga Products, launched the Rooster at the RSGB convention as a replacement for the FOXX-3.

It is very gracious of Paul to pay tribute to the FOXX radio. Whilst it is true that the Rooster is a replacement for the FOXX-3, the Rooster is far more than an enhancement of the FOXX-3. The Rooster is a new radio.

Rooster Specification

- An Easy build, fixed frequency, transceiver kit, for 40m or 30m
  - Approx 20 parts to fit
  - All SMD components are pre-installed
  - No coils to wind and no alignment required.
- Approx. 2 Watts RF Output
- Low Pass Filter. 2nd harmonic suppression ≈46dB, 3rd harmonic ≈ 60dB
- Sidetone (A pleasant sinewave)
- Full Break-In with solid state switching
- Direct Conversion receiver
- Crystal RF bandpass filter
- Front panel RIT control
- Active Audio Filter
- Tiny form factor, attractive enclosure, printed front panel, strong aluminium case
- All for less than £40

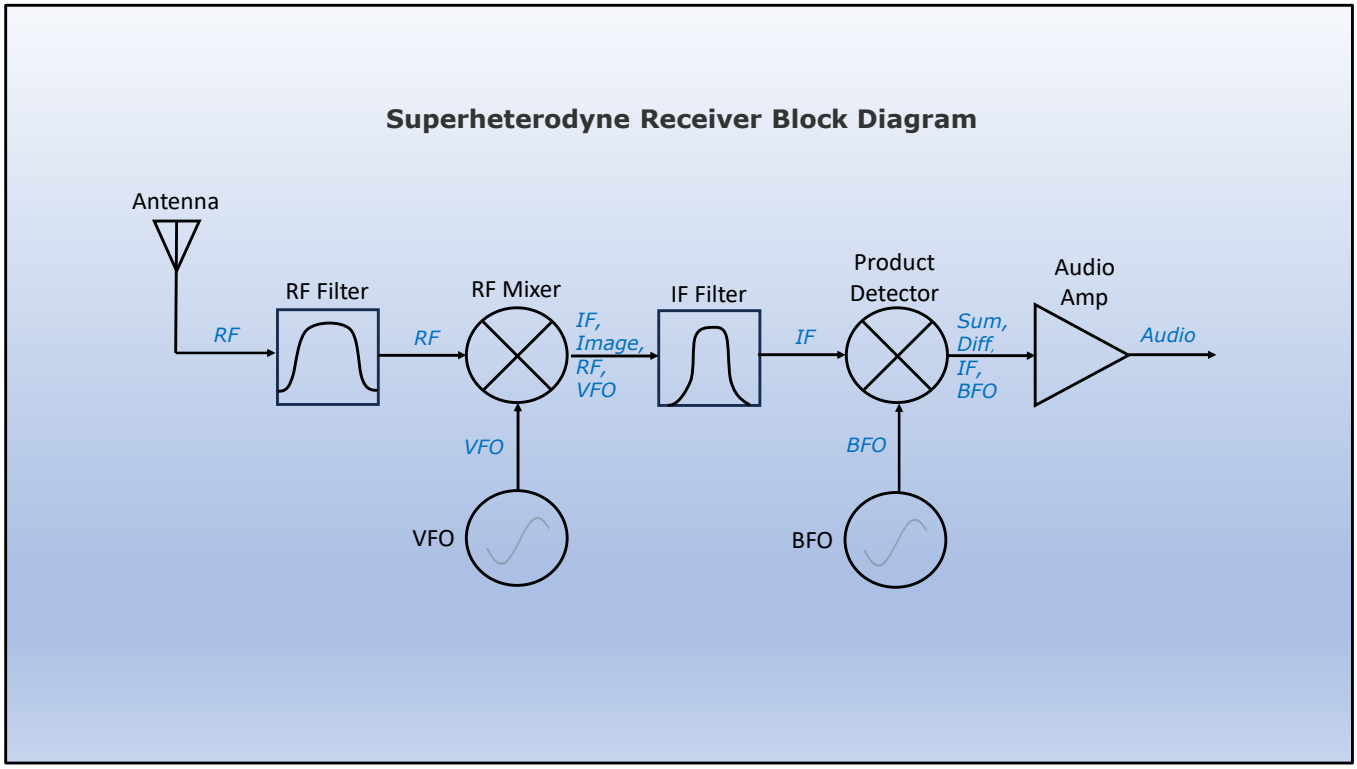
The Rooster is a great radio and not to be mistaken for a Pixie or any of the other cheap kits with disappointing performance.

In the following slides we will look more deeply at:

- Direct conversion receivers,
- Bandpass filtering,
- Receive incremental tuning
- And, Active Audio Filter

Direct Conversion

- To understand what this means, and what it means for the Rooster, we need to do some revision.
- Let's start by looking at the block diagram of a Superheterodyne receiver.



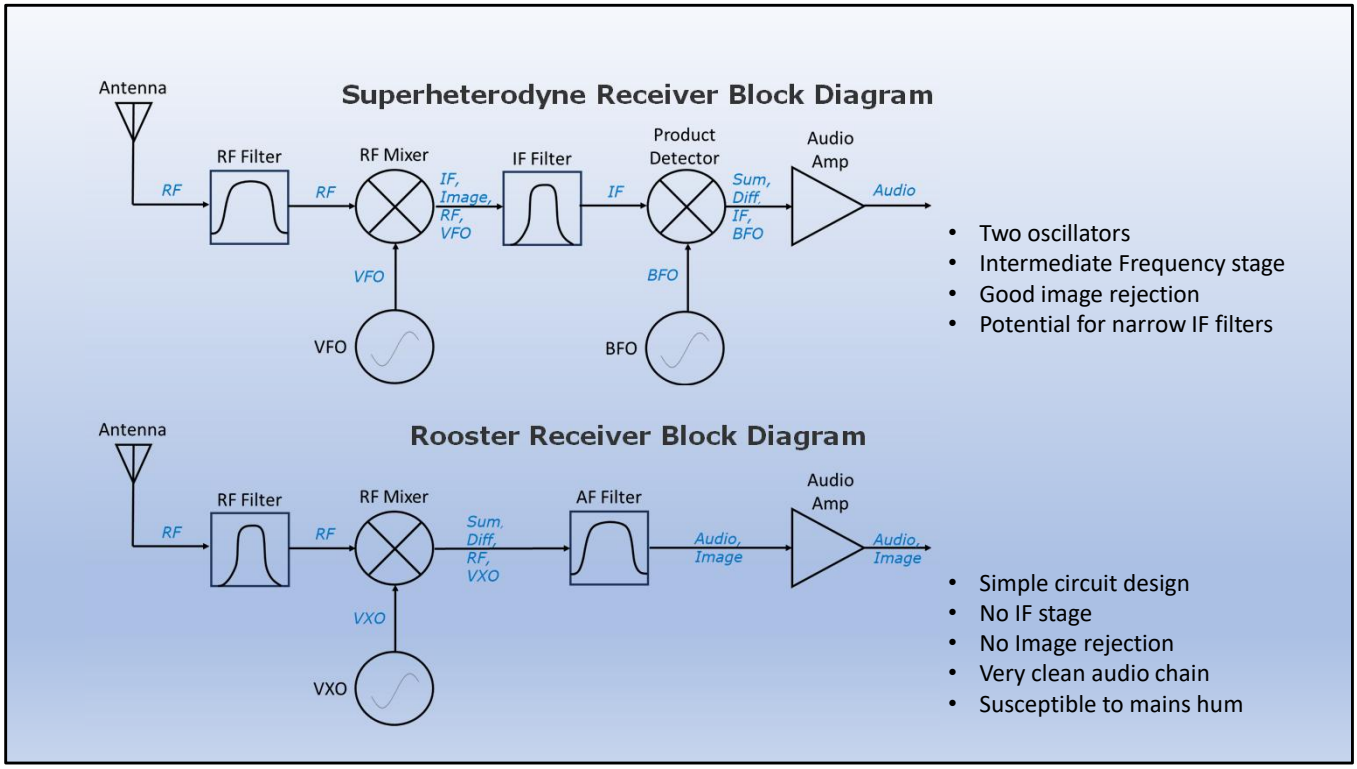
Following the signal through the radio.

The **Front-end** of the radio is a bandpass filter.
Its purpose is to filter out strong out of band signals that could overload the receiver.
It needs to be wide enough to accommodate the tuning range of the receiver.

The **RF Mixer**, mixes the filtered incoming RF with a VFO signal, creating 2 new signals: Sum and Difference. One of these new signals is at the IF frequency.

The **IF stage** filters out all signals except for the 'IF frequency'. This is typically where switchable narrow filters are placed taking advantage of the unchanging IF frequency.

The **Product Detector** and is another mixer. This mixes the IF signal with a BFO signal creating 2 new: Sum and Difference signals. Only one of these 4 signals is in the audible frequency range, the other 3 signals will typically be in the MHz range and are easily rejected by the Audio amplifier.

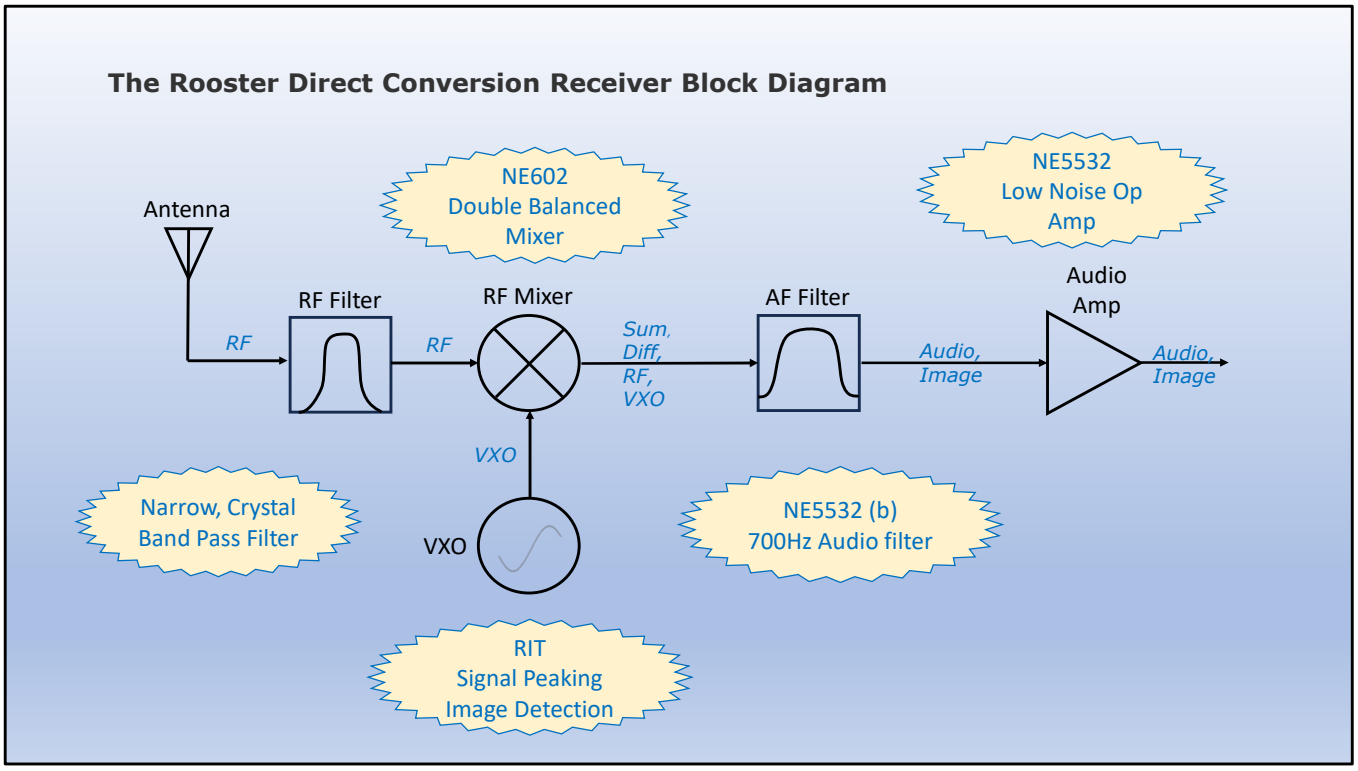


Superheterodyne characteristics: Read from slide.

The Rooster Receiver Block Diagram.

The Rooster is a Direct conversion receiver.
There is only one mixer and no IF stage.
The VXO operates close to the desired RF frequency.
The RF signal is converted directly to audio frequency in one stage.
All signals that pass through the RF filter are converted to audio!

Direct Conversion characteristics: Read from slide.



What is so special about the Rooster?

Narrow bandwidth Crystal Band Pass Filter.

- One of the weaknesses of the FOXX-3 was break-in from strong, out of band broadcast stations.
- It is not normally viable to use a crystal ladder filter as a front-end, bandpass filter on a radio with a VFO, due to the filters narrow pass band.
- The narrow pass band is a virtue on the Rooster.

NE602 Double Balanced Mixer.

- The FOXX ingeniously employed the junction of the PA transistor as the detector.
- The NE602 mixer much more effective and is used in respected radios like the Elecraft KX1
- The NE602 is vulnerable to overload, and bleed through of distortion products from broadcast stations, but the Rooster has very good front end filtering.

A low noise Op Amp

The NE5532 dual low noise Op Amp provides ample volume through earphones. A much better choice than the ubiquitous LM386.

Audio Frequency Filtering

The second half of the dual OP Amp is implemented as a 700 Hz band pass filter. It's not got narrow skirts but it makes a useful difference.

Receive Incremental Tuning

The transmit frequency is fixed. RIT provides a limited range of tuning for the receiver.
This one control enables:

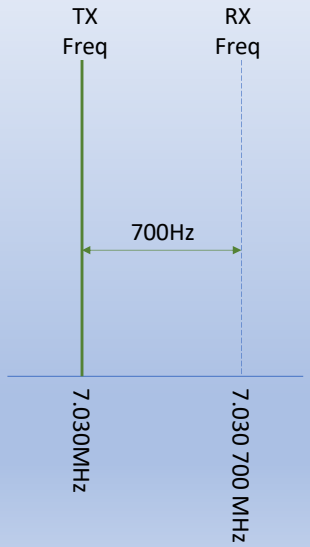
- Signal peaking,
- Image signal detection,
- and a prediction of whether a station is likely to be able to hear you.

This all adds up to a very simple radio that is a pleasure to use

Rooster Bandwidth

- In theory a direct conversion receiver without filtering has unlimited bandwidth.
  - A typical adult has a hearing range from 20Hz to 12kHz.
  - You would hear over half the CW segment of the band!
- Paul's clever use of a crystal ladder RF filter reduces the front-end bandwidth to a few kHz.
- The 700Hz audio filtering utilising the spare half of the dual operational amplifier improves the situation still further.
- The Rooster can't be considered to have narrow bandwidth filtering, but the combination of a crystal filter, a 700Hz audio filter, and RIT is surprisingly effective.

RX frequency offset for CW



- A CW signal has no audio, it is just a switched signal (OOK).
- If you select SSB on a receiver and tune towards a CW station, you will hear the tone drop in frequency. When you are perfectly tuned the station is ‘zero beat’.
- It is the difference in frequency between a TX station and the RX frequency that ‘creates’ the tone or beat frequency.
- Selecting CW mode on a receiver shifts the frequency. The radio adds a ‘frequency offset’, creating an audible tone for stations around our TX frequency.

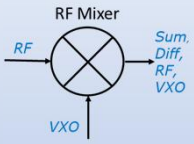
Beat frequency.
This phenomena is used when tuning a musical instrument.

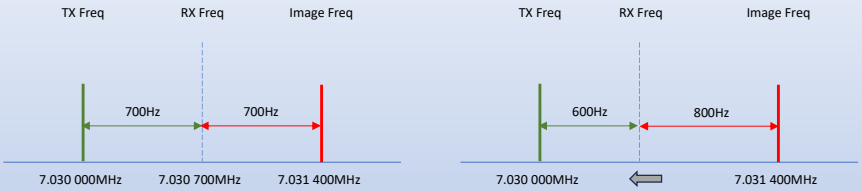
Beats or heterodyne may be heard from a twin engines propeller plane whilst turning.

Multi-engine airplanes have a propeller synchronizer to avoid this phenomenon in normal flight. Without this the beats would be heard all the time. Imagine this with 4 engines!

In CW mode the receiver is not tuned to the frequency displayed on the dial!

Direct Conversion – Image Frequency





- Mixing our incoming RF signal with a VXO signal creates 2 new signals:
  - Sum (Approx twice our RX freq)
  - Difference (Audio frequencies)
- Without an IF section differences signals are created for stations above and below our VXO frequency range.
- A station 700Hz above our offset RX will be indistinguishable from a station 700Hz below our offset RX frequency (our TX frequency).
- The unwanted signal is called the image frequency.
- Fortunately, when the RIT is adjusted the tone *(freq)* of two signals change in opposite directions.

The Crystal Oscillator

- A crystal oscillator is a mechanical oscillator, that resonates at a precise frequency, like the bell in a church tower!
- The Rooster requires the crystal oscillator to generate two frequencies.
- The resonant frequency of a crystal oscillator can be 'pulled' a small amount by adding capacitance or inductance. The effect is not linear, the further that you pull the crystals frequency, the more it resists change.
- The Rooster VXO circuit is very clever, and provides:
  - TX frequency adjustment,
  - RX offset,
  - and RIT
- If you choose to adjust the TX frequency far from Paul's recommendation, make sure that your RIT still covers your TX frequency.

A crystal oscillator is a mechanical oscillator, that resonates at a precise frequency, like the bell in a church tower!

Let's take a moment to think about this. The church bell will only ring on its given note, despite the crude method of excitation. This is what our quartz crystal does.

But the Rooster needs the crystal oscillator to generate two frequencies, one for TX and one for RX, offset by 700Hz.

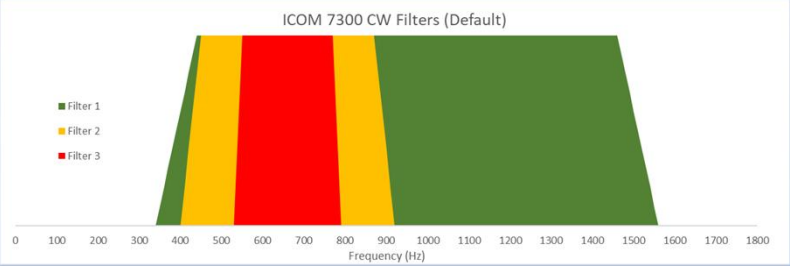
The resonant frequency of a crystal oscillator can be 'pulled' a small amount by adding capacitance or inductance. The effect is not linear, the further that you pull the crystals frequency, the more it resists change. You will see that the RIT control on the Rooster does not response linearly.

The Rooster provides TX frequency adjustment, RX offset, and RIT, by loading the crystal, with capacitors and a reverse biased diode operating as a varactor. The VXO circuit is deceptively complex. This stuff is difficult to do. Hat's off to Paul.

If you choose to adjust the TX frequency far from Paul's recommendation, make sure that your RIT still covers your TX frequency.

CW Filters

- Our Rooster filtering is reasonably wide, we can hear stations ‘near’ our frequency.
- Other stations will typically have more and narrower CW filters.



Stations from 350Hz below our frequency to 850Hz above should be able to hear us if they are using their widest CW filter (Filter 1 above). Beyond this range they are unlikely to reply.

Beware: The Rooster RIT will enable you to ‘peak’ stations operating outside this range.

A shout out for QRP

- When there is no propagation there is no propagation.
  - Extra power does not create propagation.
- When propagation is good you don't need lots of power.
- When propagation is marginal or you're trying to bust a pile up, extra power can enable you to shout louder than the crowd.

- 2 Watts is 17dB down on a 100w signal, nearly 3 S points.
- The Rooster operates on the QRP Centre of activity.
  - People will be looking for your 'weak' signals.

My Roosters

- TX frequency set to the maximum
  - Maximise useful RIT range
- RIT knob vertical for stations on my frequency
- Additional labelling:
  - TX frequency
  - RIT frequency range and direction
  - Differentiation of stations on image frequency
  - RIT marker for lowest frequency likely to hear my calls