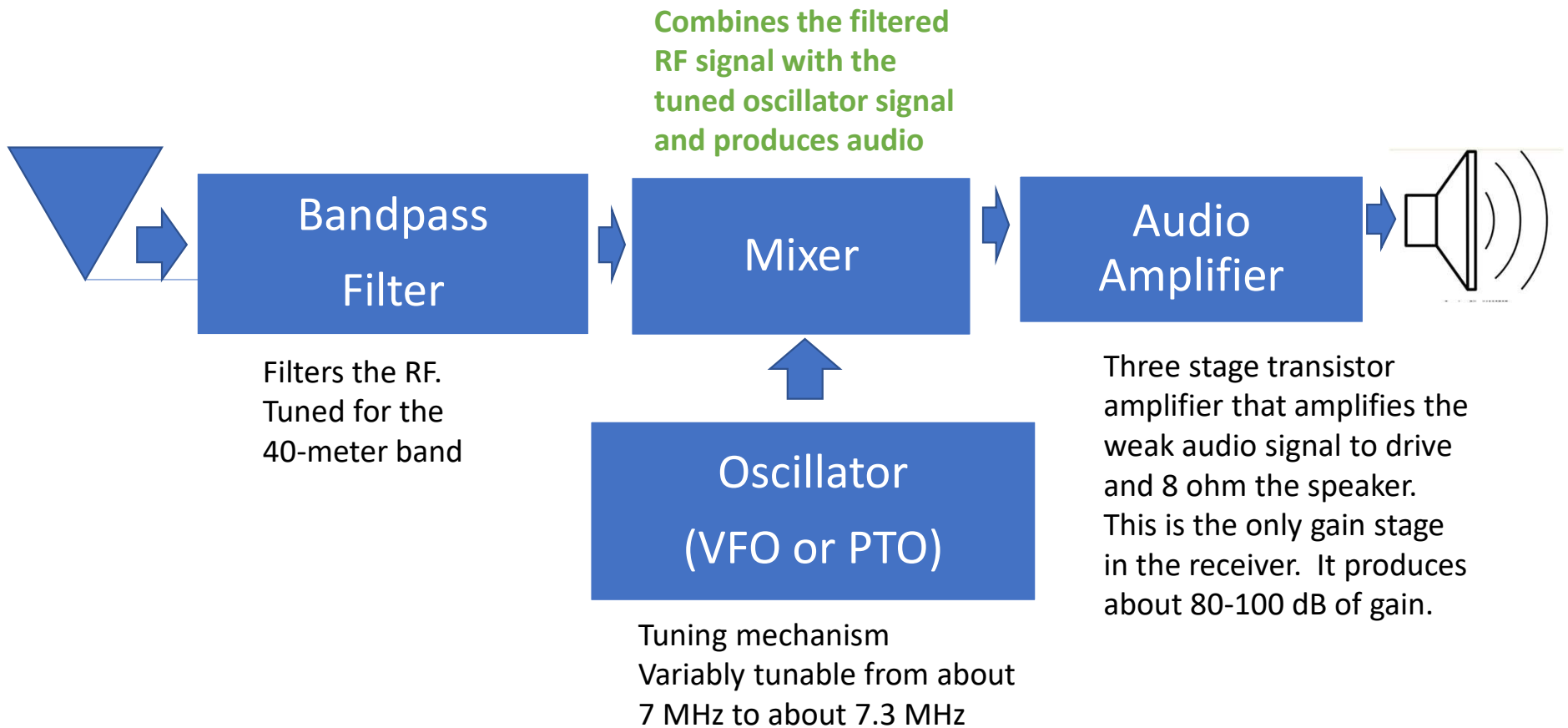


# SolderSmoke Challenge Direct Conversion Receiver

Diode Ring Mixer and Diplexer

Jan 2025

# A Block Diagram of our Receiver



# Recall what a direct conversion receiver is

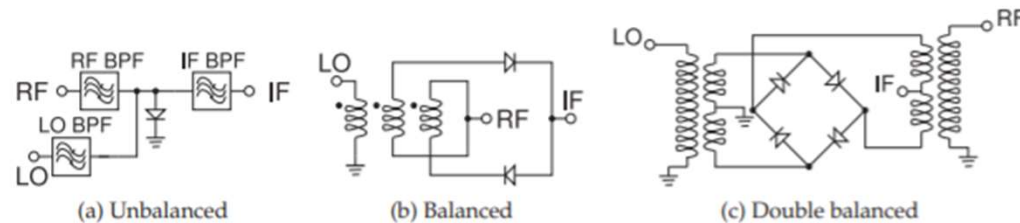
- The signals this receiver will work with are radio waves at about 7MHz.
- Our ears respond to acoustic waves in the air at around 300 to 3 kHz.
- We need to convert the radio signals to sound waves that we can hear.
- We do this conversion in one step, thus: Direct Conversion.
- The MIXER does the conversion

Antenna signal coming in at 7.201 MHz.  
Your oscillator is set to 7.200 MHz.

- The Sum frequency: 14.401 MHz
  - Radio frequency - we can't hear it, but your receiver can
- The Difference frequency: .001 MHz (or 1 kHz)
  - Audio frequency typically about 300Hz – 3kHz
- So, we take the difference frequency, we amplify it and listen to it!
- We discard the sum frequency.
- THAT'S THE ESSENCE OF MIXING. THAT'S WHAT THE RECEIVER DOES.

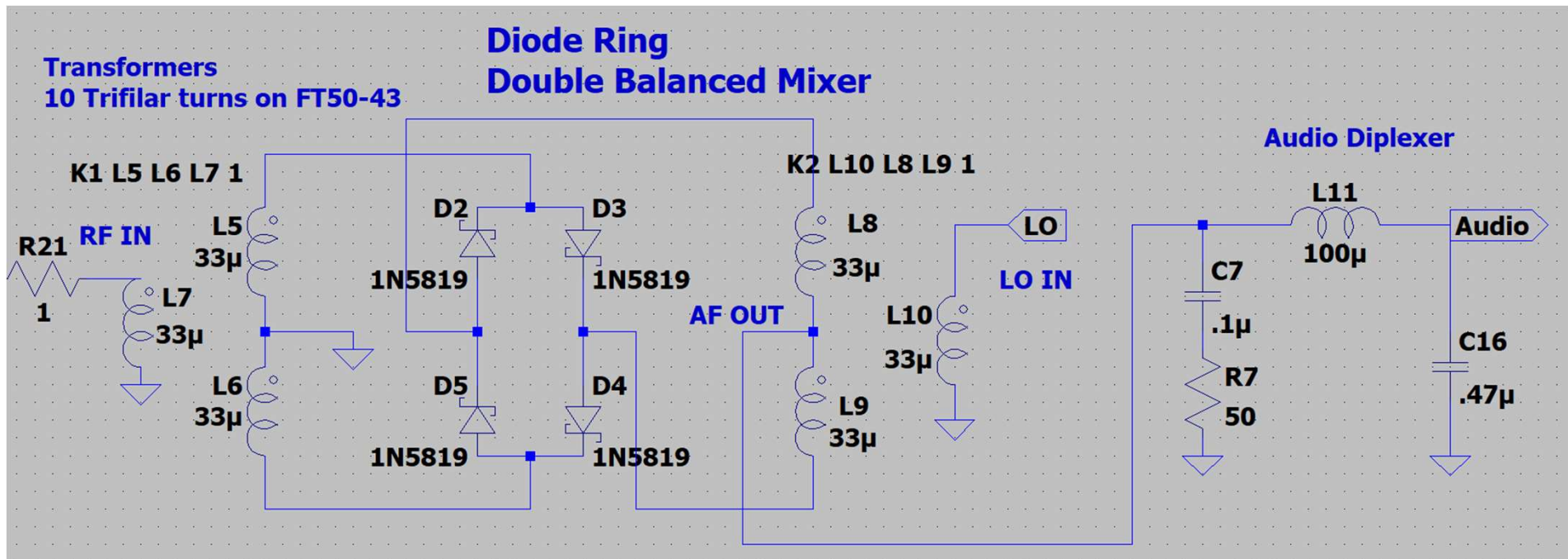
# Many types of mixers

- Passive diode mixers



“Double Balanced Mixer: Increased linearity compared to single-balanced mixer. All ports of the mixer are inherently isolated from each other. Can be implemented with passive mixing elements not requiring biasing. Inherently broadband.” (source: Microwave and RF Design IV: Modules (Steer))

- Transistor switching mixers - the Gilbert Cell
- Active MOSFET mixers – mix and amplify



### Transformer schematic hints

- Trifilar – 3 windings twisted together
  - (as opposed to bifilar – 2 windings)
- Inductance value with core type determines the number of turns (Online calculator toroids.info)
- Phase dots show how to interconnect the windings
  - If holding the transformer vertically think of the phase dots as the top winding
  - The BOTTOM of L5 is connected to the TOP of L6

### DIPLEXER

- Provides 50-ohm termination for all frequencies of interest
- Low pass LC filter with cutoff at ~23kHz
- Helps with AM broadcast breakthrough

# Myths, Legends, Lore and Truth

- “You need 7dBm (or 10dBm) to drive a diode ring mixer”
  - **MYTH** – you need enough voltage to turn the diodes on and off and the mixer will mix
- “You must provide 50 ohms termination at all 3 ports of the mixer”
  - **LEGEND** – the mixer may have less loss and fewer harmonic products if all ports are terminated in 50 ohms – but it is not required for mixing
- “You must (or can’t) use a simple silicon 1N4148 switching diode (or a name your favorite diode)”
  - **LORE** – virtually any small diode will work in a diode ring – could be silicon junction, silicon Schottky-barrier or gallium-arsenide, etc.
- “You must carefully match the diodes, or the mixer won’t work well”
  - **MYTH** – with modern manufacturing tolerances are close enough – just pick 4 from the same bath
- “Any non-linear circuit – even a single diode will mix”
  - **TRUTH**

# For more on exactly how a mixer works

- Alan Wolke, W2AEW
  - YouTube Video #167:
    - How a Diode Ring Mixer works | Mixer operation theory and measurement
    - <https://youtu.be/junuEwmQVQ8?si=zinwuz9FcBDbUXM6>
    - Just an aside - Alan uses 1N5711 Schottky diodes in his demonstration
- SolderSmoke Blog
  - In this blog post and YouTube video, Bill, N2CQR explains how our diode mixer works.
    - <https://soldersmoke.blogspot.com/2022/10/how-diode-ring-multiplies-by-1-and-1.html>