Superhet Receiver Theory

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For the Oak Forest Amateur Radio Club
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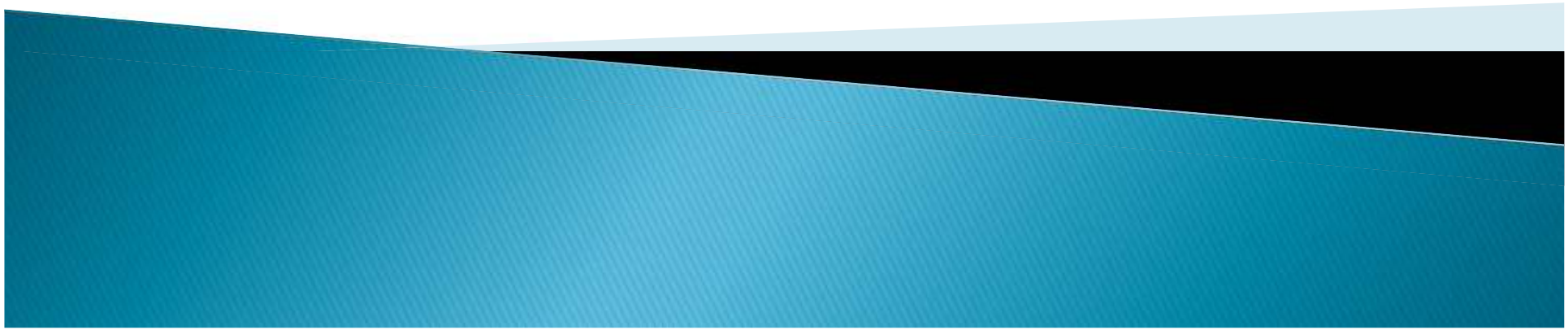
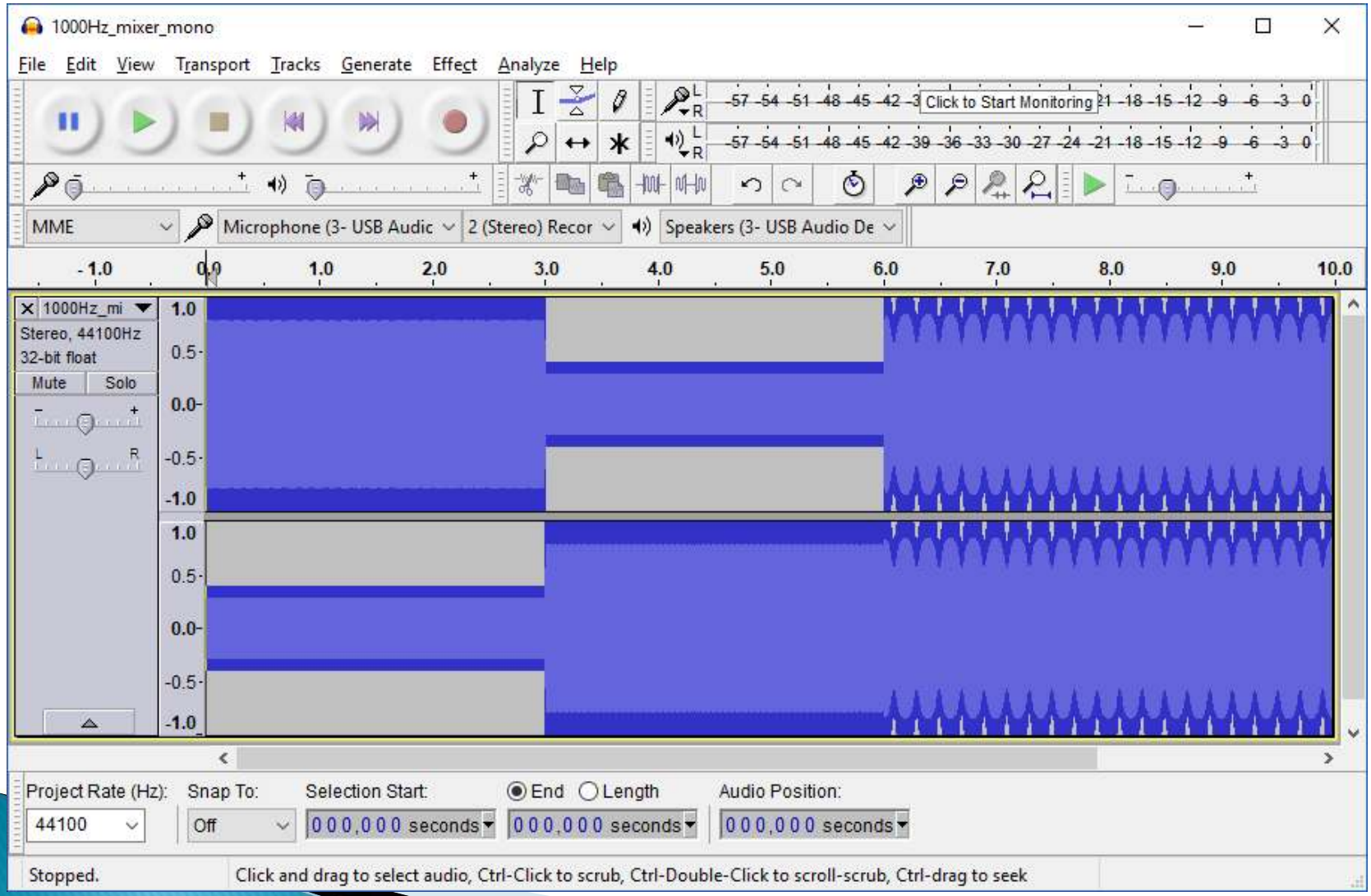


Background

- A very large percentage of radio receivers in use today utilize mixers to translate the radio signal from the RF spectrum to a lower frequency that can be optimized for signal amplification and bandpass filtering
- Musicians are well aware of “beat frequencies” when they try to tune there instruments to others in their ensemble
- Two tones of 1000Hz and 1010 Hz are mixed in this embedded audio wave file, yielding a beat frequency of 10Hz

Wave File View



Background (2)

- The beat frequency is slowest when the two frequencies are nearly the same
- Radio Frequency mixers behave in the same way but the frequencies are not nearly so close together
- A trigonometric identity defines the behavior:

$$\cos(f1*t) * \cos(f2*t) = \tfrac{1}{2} (\cos((f1+f2)*t) + \cos((f1-f2)*t))$$

History

- Major Howard Armstrong filed (1917) and was granted a patent in 1919 for the super(sonic) heterodyne radio receiver
- He was hired by RCA in the early 1920s to create the first commercial, mass-produced implementation
- The first broadcast band receiver implementations created an intermediate frequency (IF) of ~45K Hz

Current Implementations

- Modern broadcast band AM radios use an intermediate frequency of 455KHz
- Modern broadcast band FM radios use an IF frequency of 10.7MHz
- All RF receivers in use today except for direct sampling SDRs use the superhet technique

Additional Information

https://www.youtube.com/watch?v=Mm7WfVzr1ao
https://www.youtube.com/watch?v=JuuKF1RFvBM
https://www.youtube.com/watch?v=7eTfF67Ka5w
https://www.youtube.com/watch?v=-3IXAunoZps