

Multi-Channel Signal Transmission over Fiber

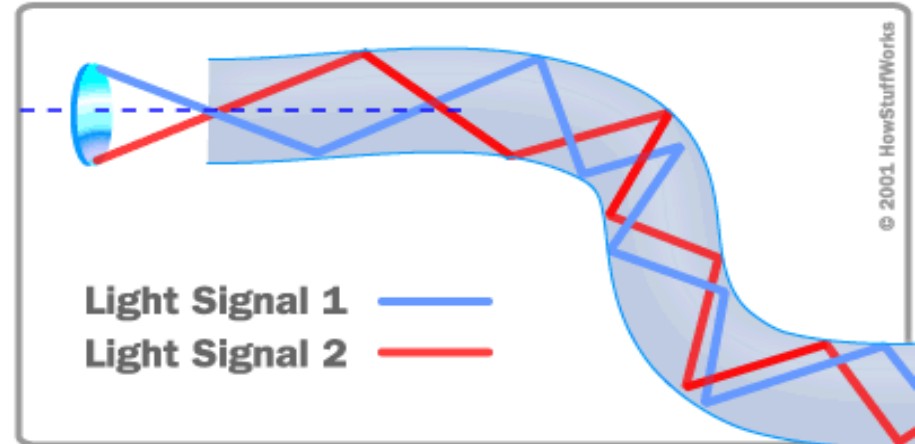
Max Justicz
Yanni Coroneos

Design Goals

- FM modulate 3-4 different signals of potentially large bandwidth
- Transmit over fiber optic cable
- Receive and demodulate on the receiver with low distortion

Why fiber?


- Less attenuation than copper
- Less noise than copper
- Doesn't require as much reamplification



Why RF?

- Wavelength Division Multiplexing is too expensive
- RF is common and well-understood

Our Products >> Fiber Optic Pro-730 Core Alignment Fusion Splicer Kit



Fiber Optic Pro-730 Core Alignment Fusion Splicer Kit

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Price: **\$6,017.90**

Item #: FS-730FT1

* Marked fields are required.

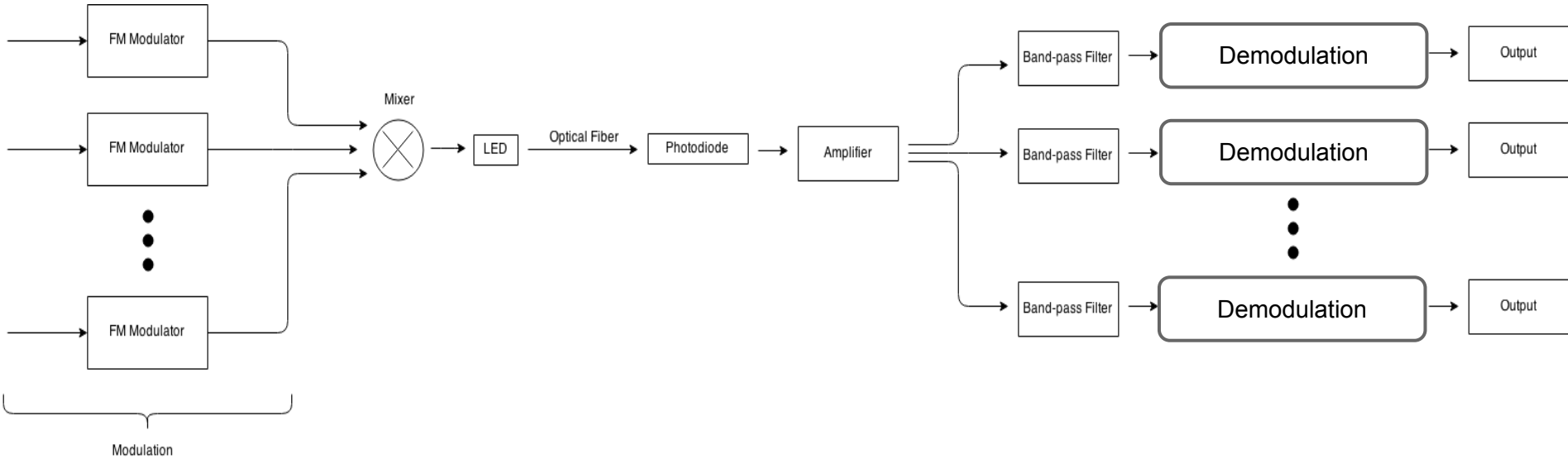
Qty:

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Fibertronics offers A very reliable and dependable fusion splicer. Fiber Optic Pro-730 Core Alignment Fusion Splicer. This device is for use within several areas of fiber optic deployment, Premise (on site), OSP (outside plant), or FTTX (fiber to the subscriber) splicing. The PRO-730 fusion splicer is designed to work with all the popular fiber types and in all weather conditions. The dual axis view, reversible color monitor, and control panels on both sides of the unit assure splicer efficiency in just about any work environment.

Block Diagram



Dividing the work

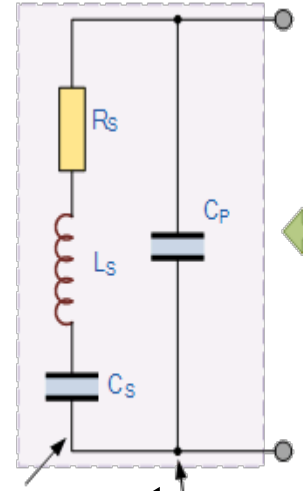
- Yanni: Modulation
- Max: Demodulation



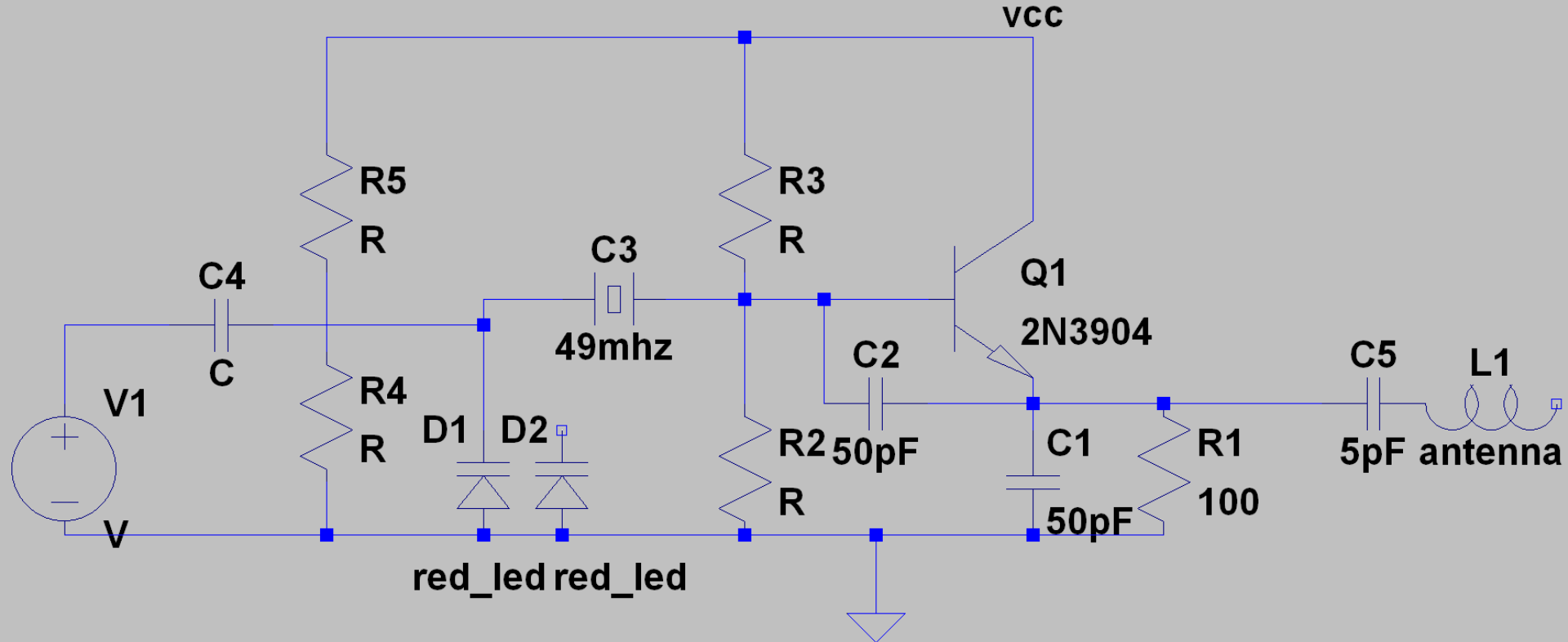
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Transmitting: FM Modulator

- VCXO (crystal based)
 - crystals have extremely high Q
 - reduces part count
 - act as tuned LC circuit
- Modulation and mixing happens in one step



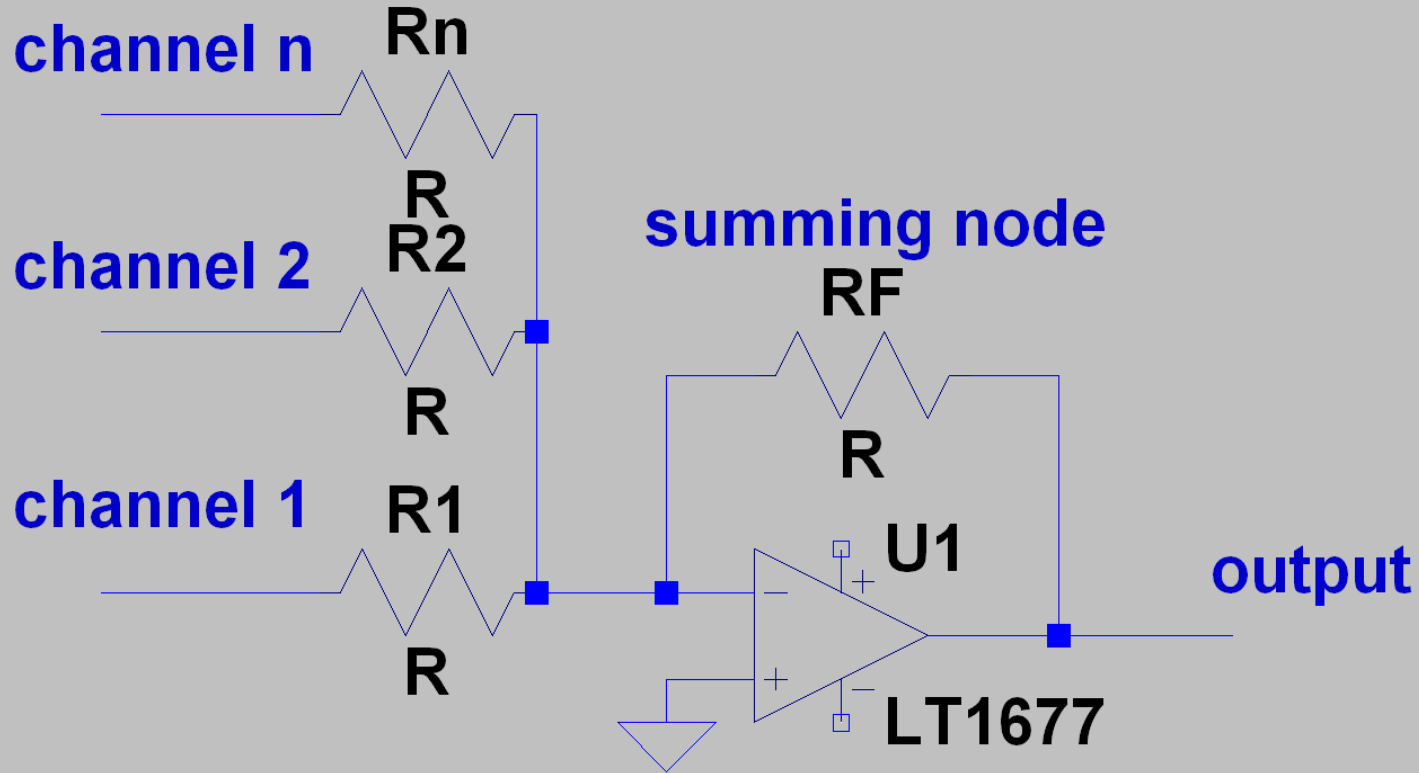
FM Modulator



Mixing the Outputs

- Fourier transform is linear so a simple op-amp adder circuit will suffice
- 1GHz GBW op-amp
 - when moving to a pcb, GBW in excess of 3GHz are easy to obtain in common footprints

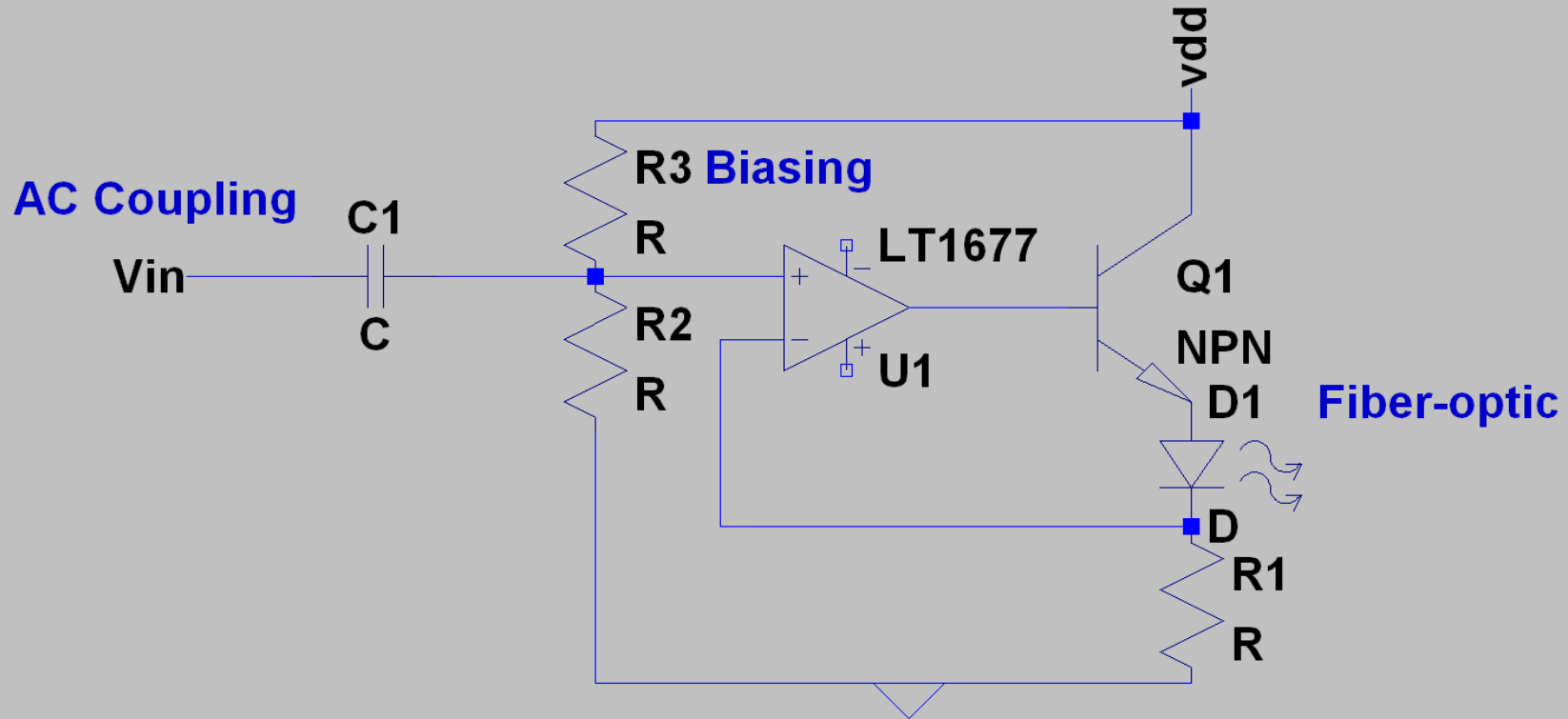
Summing Amp



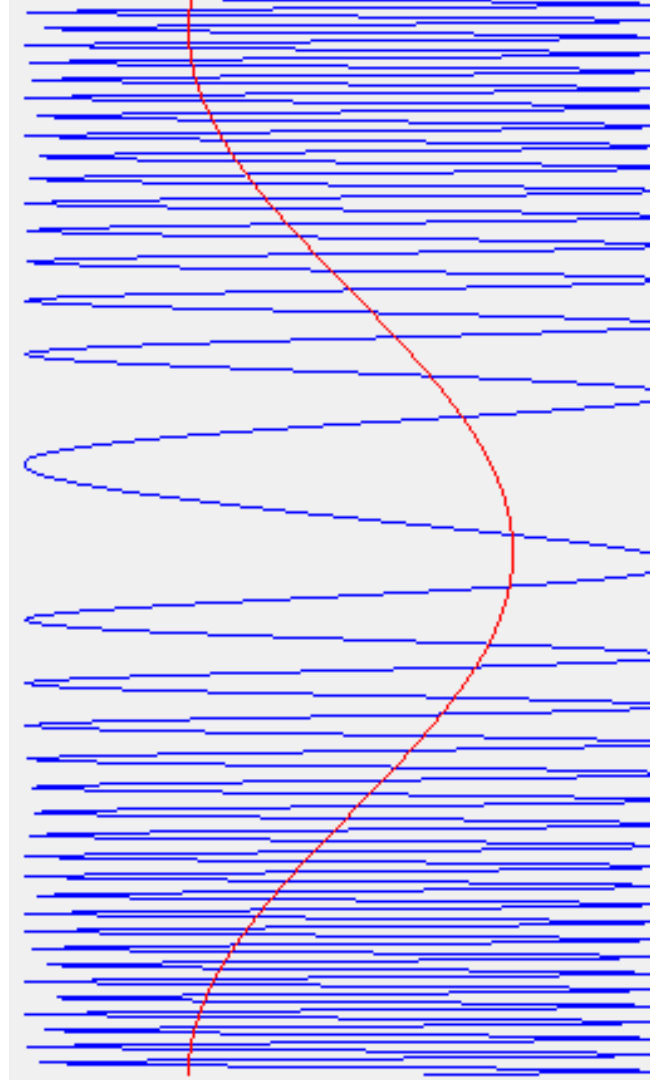
Transmitting Mixed Signals

- Transmitter is LED, those run on current sources
- Make a VCCS
 - wrap feedback around a transistor

Diagram of a VCCS

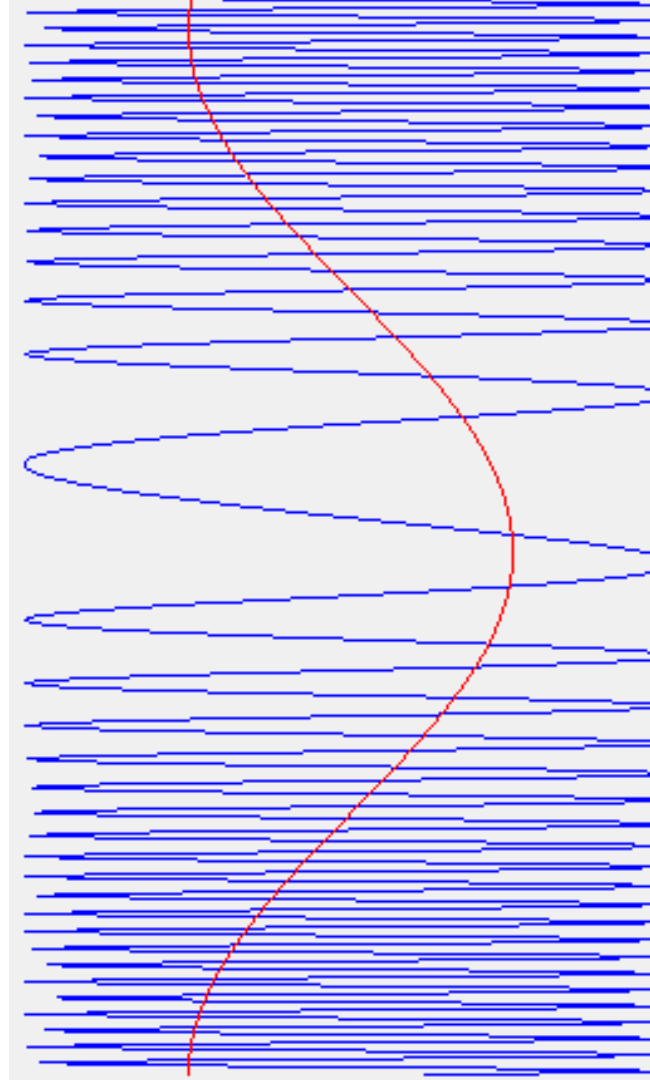
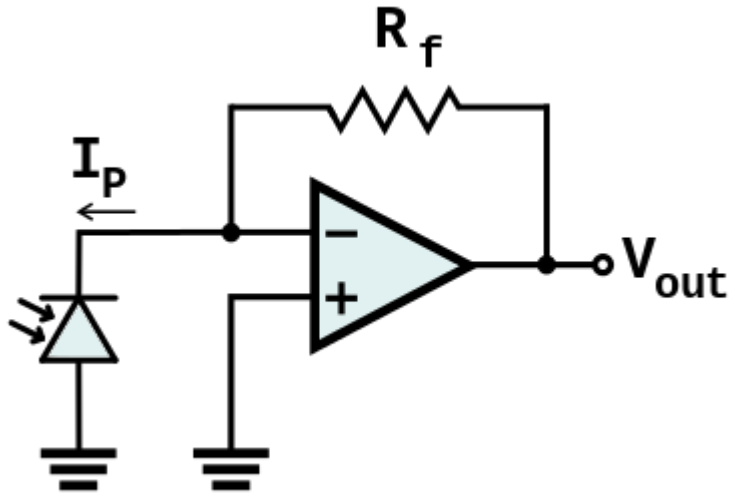


Receiving/Demodulation



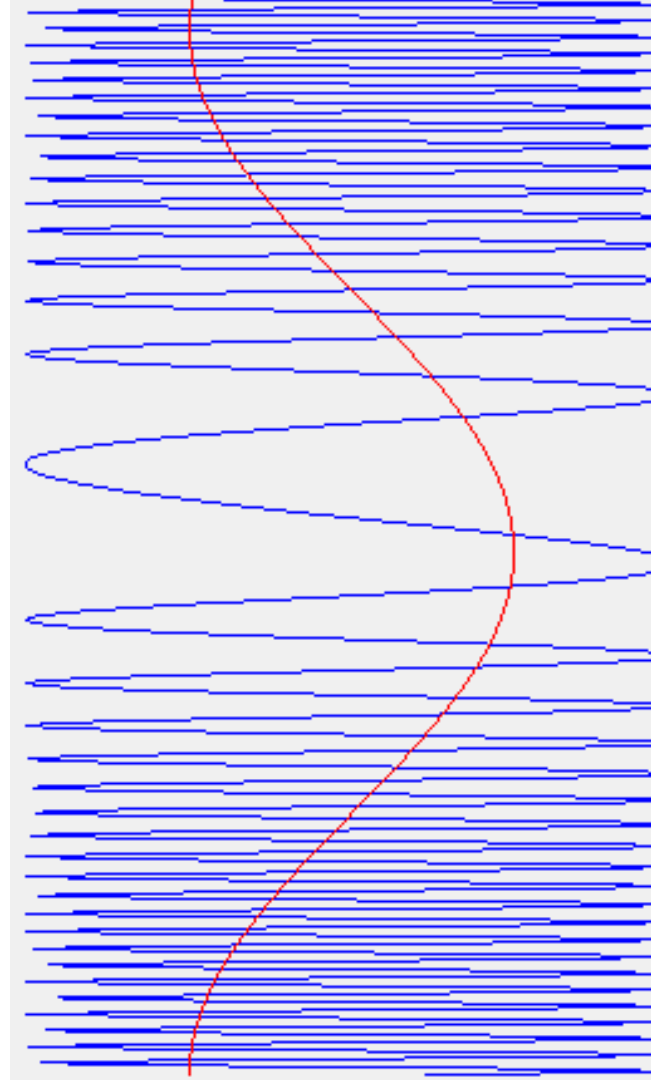
Photodiode -> Voltage

- Transimpedance amp
- (we've all seen this)



Receiving

- Many ways to demod FM
 - Quadrature demodulation
 - Slope detection
 - Superheterodyne receiver
 - Super regenerative receiver
 - Op-amp differentiation
 - Phase locked loop (PLL)



Why does differentiation work?

$$A \sin(2\pi f_c t + \beta \sin(2\pi f_m t)).$$

$$\frac{d}{dt}.$$

$$A[\text{stuff}] \cos(2\pi f_m t) \sin(2\pi f_c t + \beta \sin(2\pi f_m t)).$$

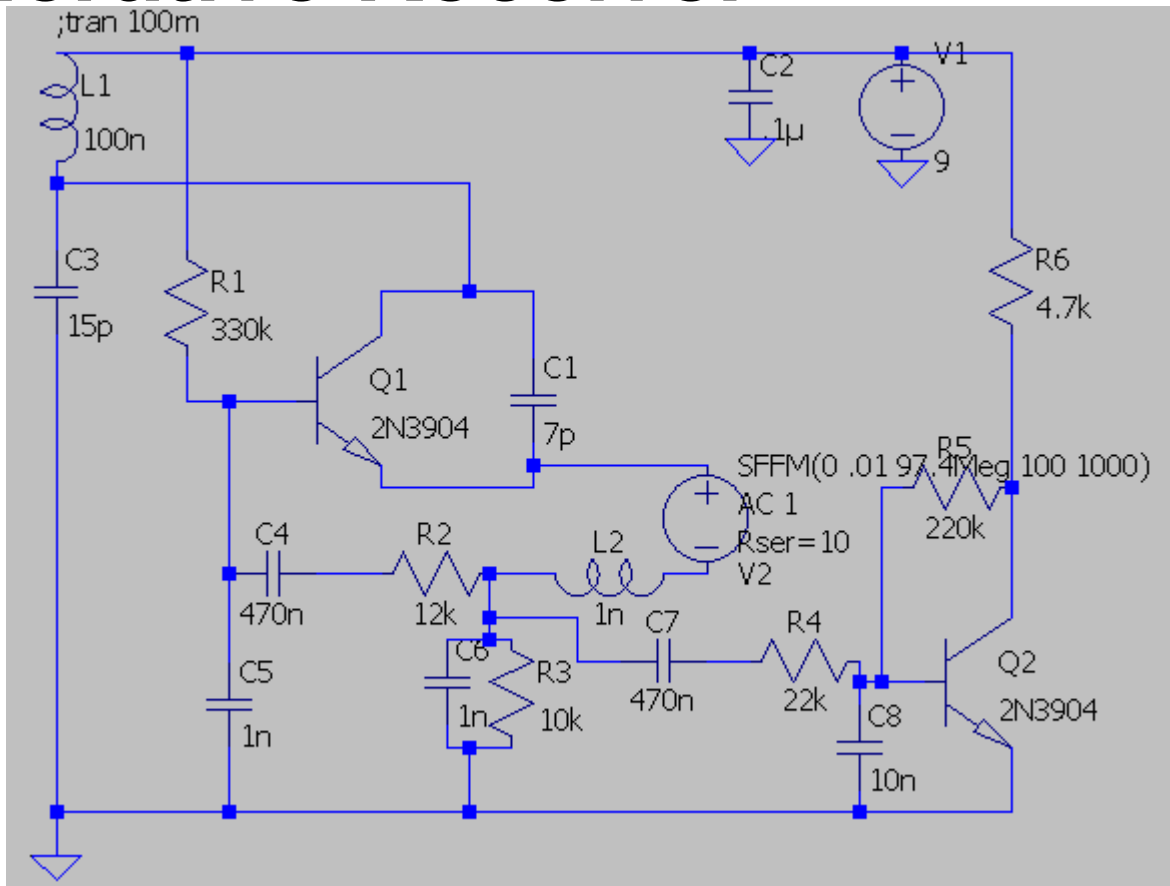
Why does differentiation work?

- FM -> Envelope
- Envelope -> Diode -> LPF
- Nyquist's Theorem
- Must sample at twice the highest frequency component

Super Regenerative Receivers

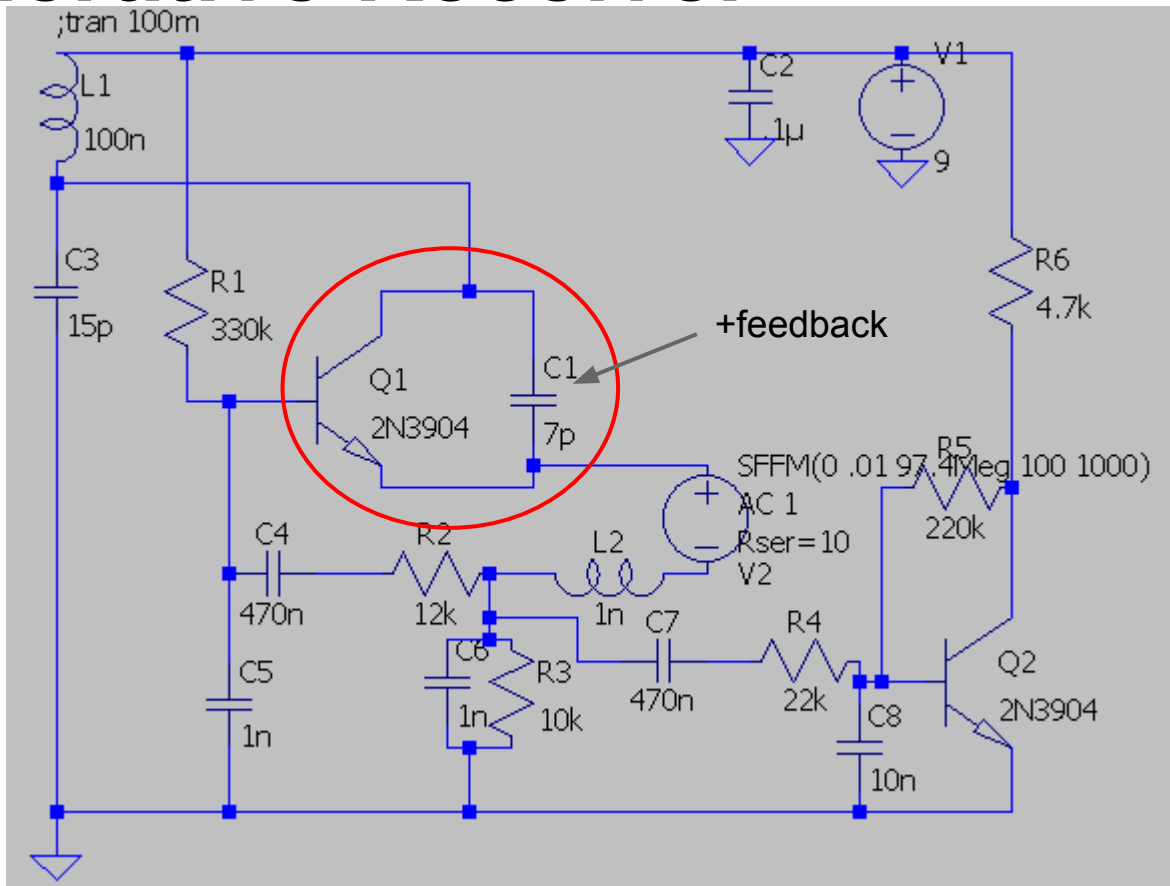
- Transistor with positive feedback
- Slope detection
- Amplify and demodulate in one step
- Popular ~1915
- Generally replaced by superhet receivers

Regenerative Receiver



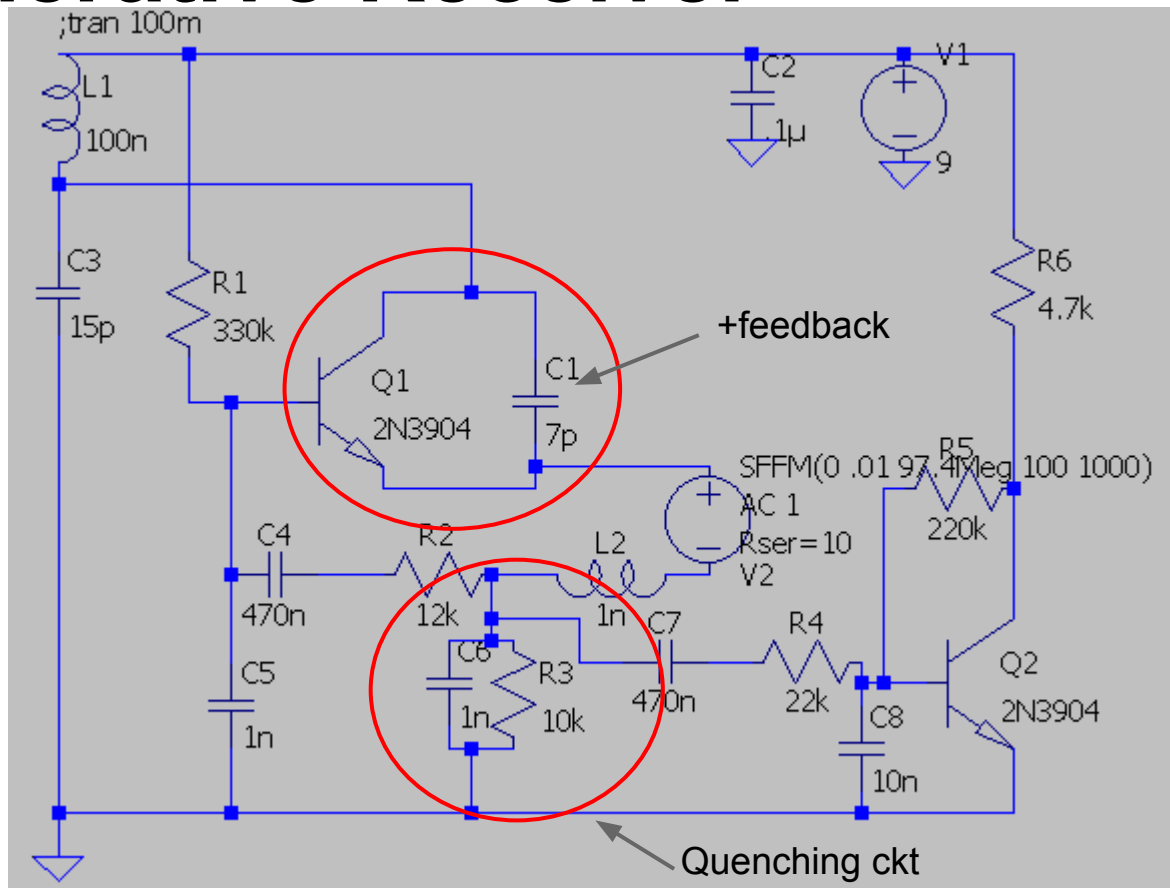
(Thanks, ke3ij!)

Regenerative Receiver



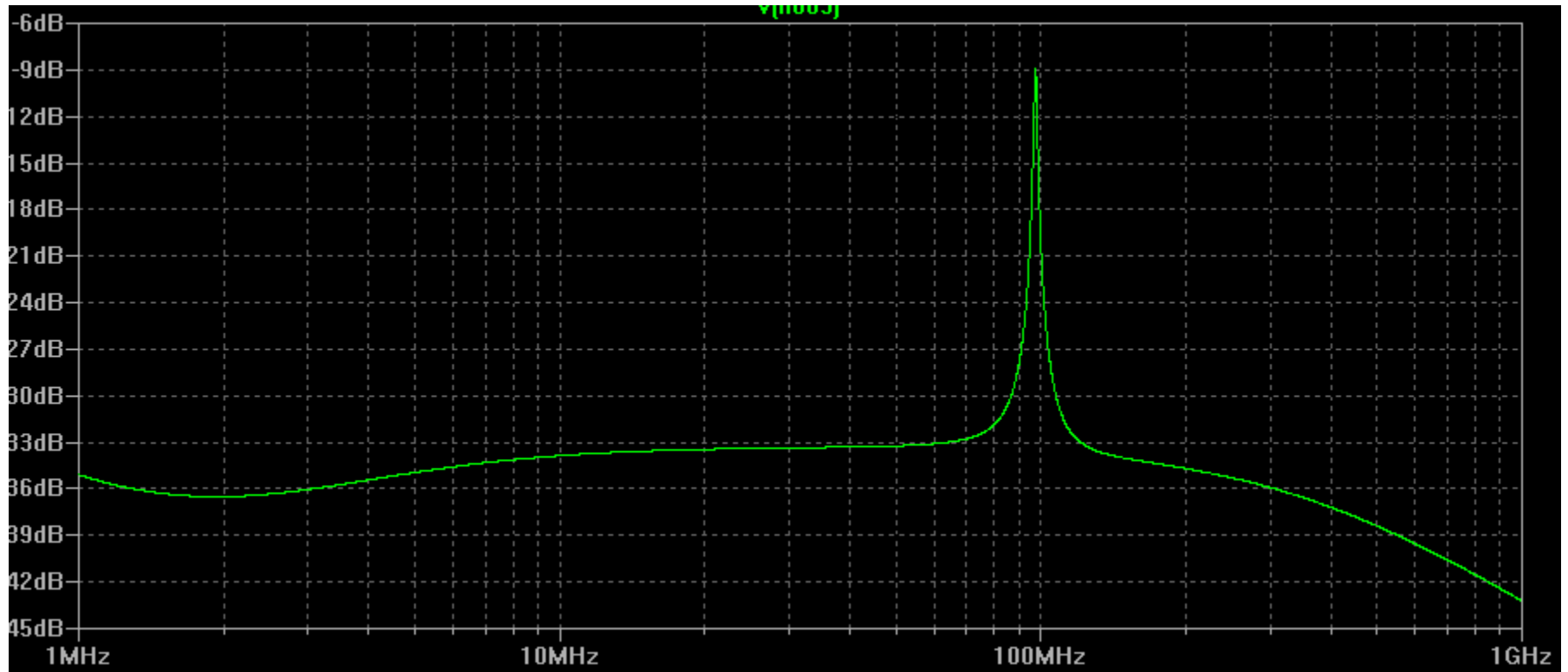
(Thanks, ke3ij!)

Regenerative Receiver



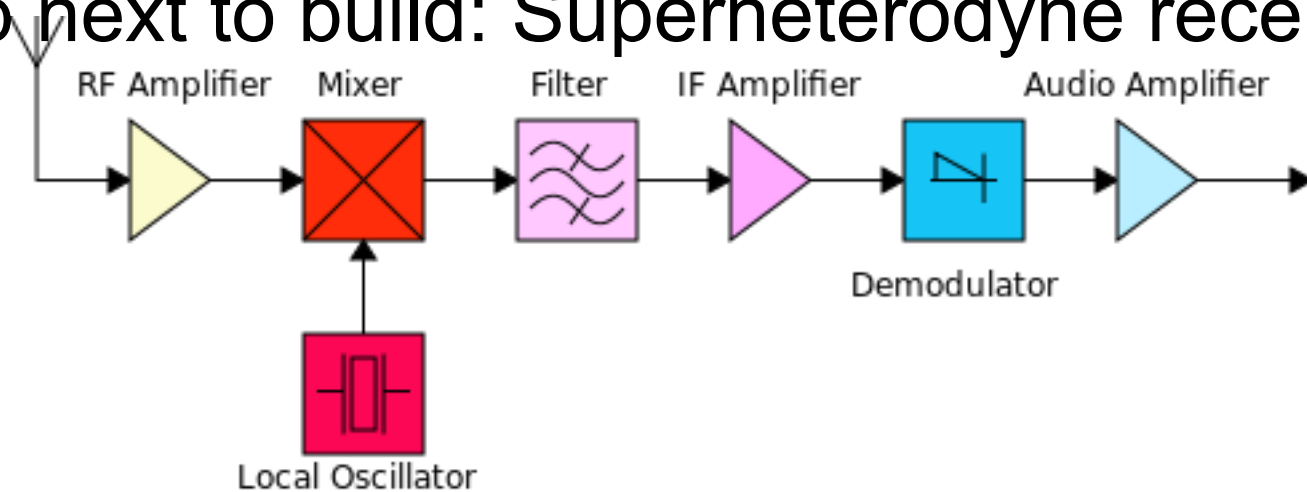
(Thanks, ke3ij!)

Frequency Analysis (LTSpice)



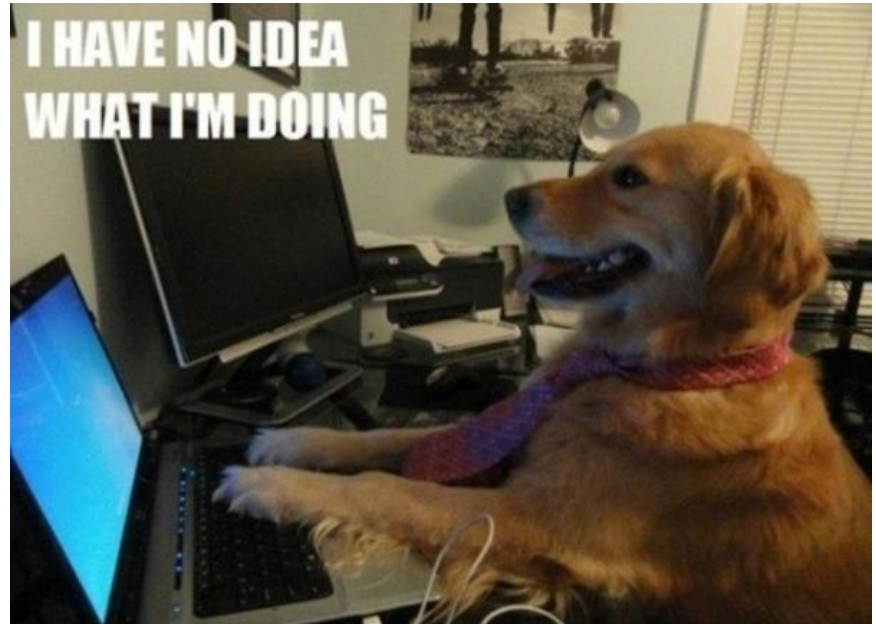
Super Regenerative Receivers

- Not optimal for this application (best at WFM)
- Up next to build: Superheterodyne receiver



DEMO!

- Tune in to 49.9 MHz FM
- Pirate radio



Timeline

This week:

- Build more receiving circuits, pick what works best, try to maximize SNR
- Replace radio with fiberoptic

Next week:

- Nail down our mixing technique
- Design and order boards, assemble

Then -> Checkoffs:

- **Debug!**

