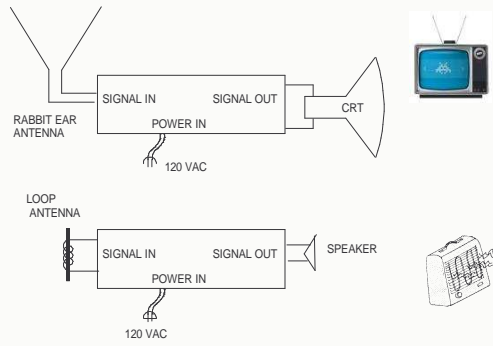


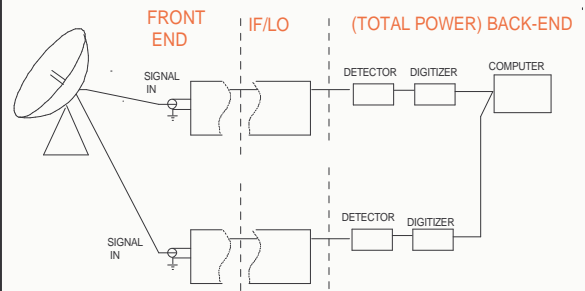
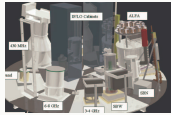
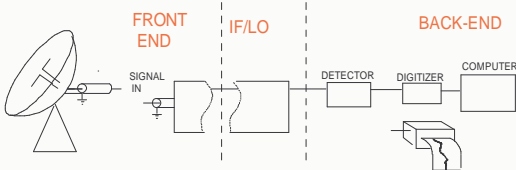
## MICROWAVE RECEIVER SYSTEMS

Jon Hagen, Sr. Staff Engineer

1. SINGLE/DUAL POLARIZATION
2. SUPERHETERODYNE PRINCIPLE
3. RECEIVER NOISE



BROADCAST RECEIVERS



DUAL POLARIZATION



POLARIZATION SEPARATORS



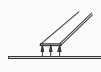
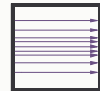
COAXIAL LINE: ONLY ONE MODE



COAXIAL LINE: ONLY ONE MODE



SQUARE WAVEGUIDE: TWO MODES



PRINTED CIRCUIT TRACE: ONLY ONE MODE

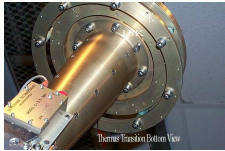


RECTANGULAR WAVEGUIDE: ONLY ONE MODE

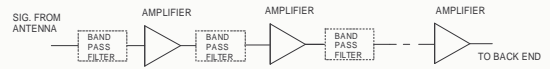


CIRCULAR WAVEGUIDE: TWO MODES

SINGLE AND DUAL-MODE TRANSMISSION LINES



FRONT-END PHOTOS



PRE-SUPERHETERODYNE RECEIVER BLOCK DIAGRAM

- SIGNAL FREQUENCY MAY BE TOO HIGH FOR PRACTICAL NARROW BAND FILTERS
- DIFFICULT TO CHANGE THE CENTER FREQUENCY
- TOO MUCH GAIN - MUST BE WELL SHIELDED OR WILL OSCILLATE
- BACK END MUST BE NEARBY TO AVOID TRANSMISSION LOSS
- SIGNAL FREQUENCY MAY BE TOO HIGH FOR AMPLIFIER TECHNOLOGY

PRE- SUPERHETERODYNE



Atwater Kent Model 4560  
Western Historic Radio Museum  
Virginia City, Nevada

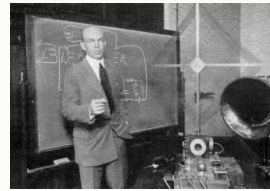
SUPERHETERODYNE

Philco Model 29-70 <http://www.grandjuryradio.com/philco2970.html>

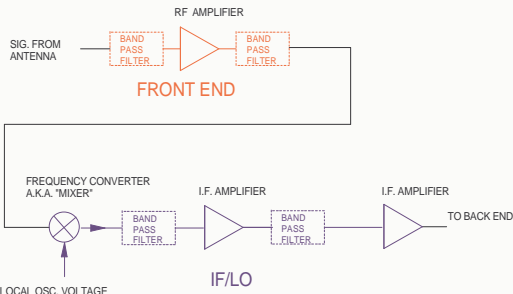


SINGLE-KNOB TUNING

ARMSTRONG & THE SUPERHETERODYNE



[http://www.geocities.com/neveyaakov/electro\\_science/armstrong.html](http://www.geocities.com/neveyaakov/electro_science/armstrong.html)

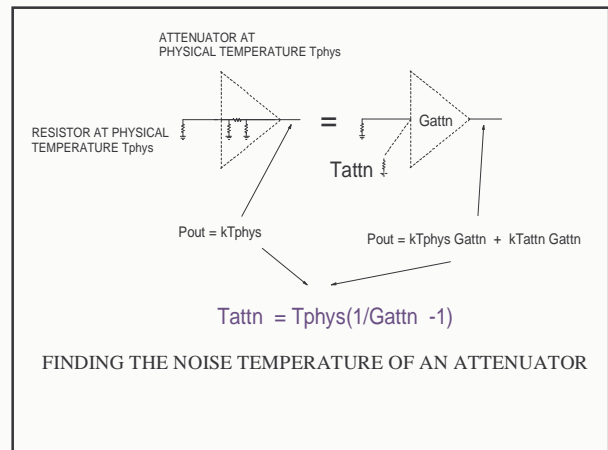
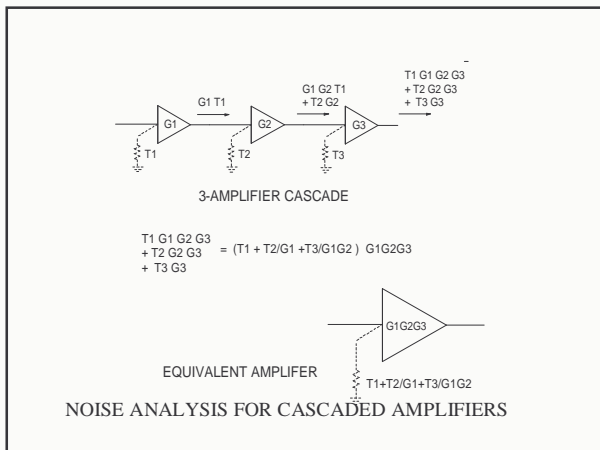
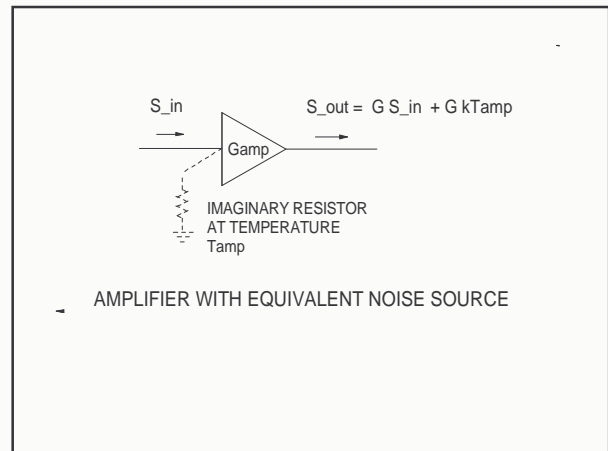
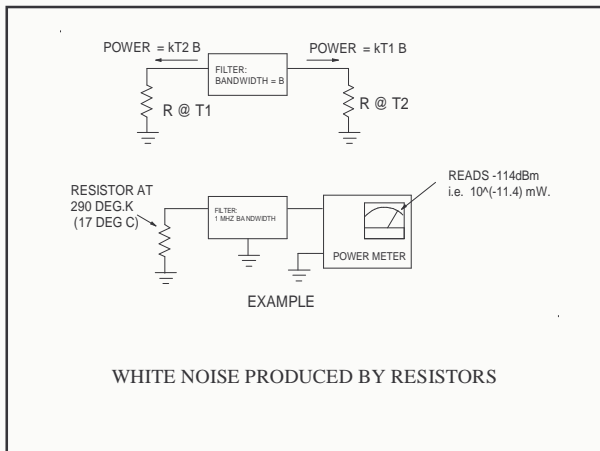
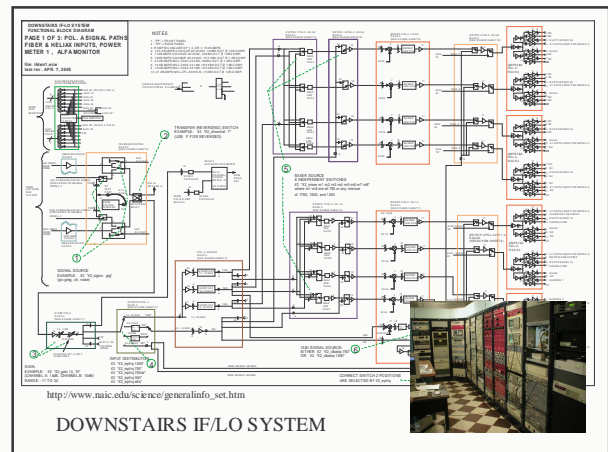
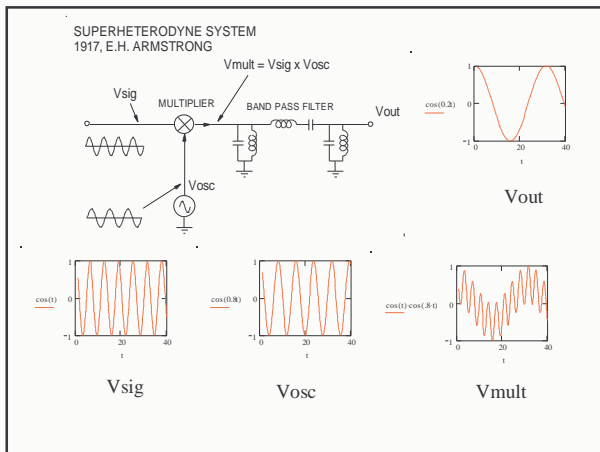


SUPERHETERODYNE RECEIVER BLOCK DIAGRAM

$$\cos(\omega_L t) \cos(\omega_R t) = \frac{\cos[(\omega_R - \omega_L)t]}{2} + \frac{\cos[(\omega_L + \omega_R)t]}{2}$$

$$\cos(\omega_L t) \sum_R A_R \cdot \cos(\omega_R t) =$$

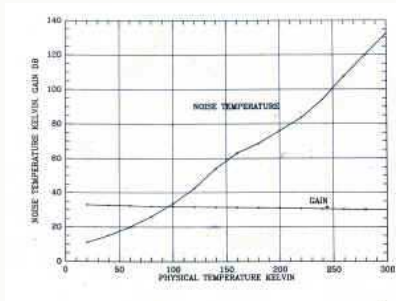
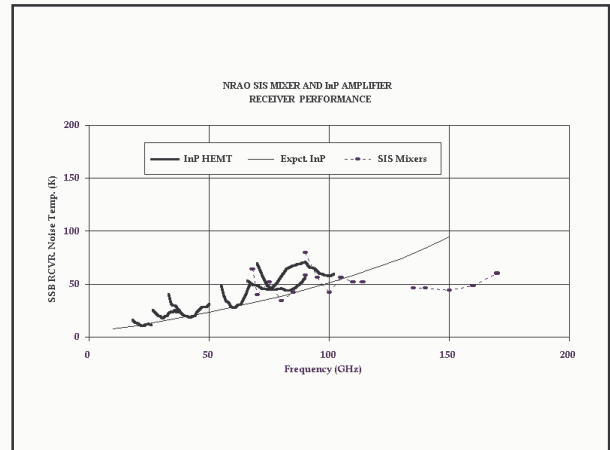
$$\sum_R \frac{A_R \cdot \cos[(\omega_L - \omega_R)t]}{2} + \sum_R \frac{A_R \cdot \cos[(\omega_L + \omega_R)t]}{2}$$



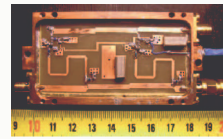
Noise Figure - Alternate way to express the internal noise of an amplifier:

$$NF_{amp} = (290 + T_{amp})/290 = 1 + T_{amp}/290$$

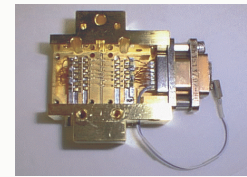
Note: NF is the ratio of the output noise power to the part of the output noise power attributable to the source when the source has a temperature of 290K.



Berkshire Technologies, Inc.



700 MHz Balanced Amplifier  
Leif Roschier and Pentti Hakonen/Helsinki University of Technology.



NRAO 100 GHz 75-110 GHz

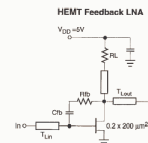


Fig. 2. Schematic of the low noise HEMT feedback pre-amplifier.

K. W. Kobayashi, D. K. Useneko, T. R. Block, A. K. Oki, and D. C. Strit

## LOW-NOISE AMPLIFIERS