MICROWAVE RECEIVER SYSTEMS

Jon Hagen, Sr. Staff Engineer

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

BROADCAST RECEIVERS
DUAL POLARIZATION
POLARIZATION SEPARATORS

SINGLE AND DUAL-MODE TRANSMISSION LINES
FRONT-END PHOTOS

PRE-SUPERHETERODYNE RECEIVER BLOCK DIAGRAM

- SIGNAL FROM ANTENNA
- AMPLIFIER
- AMPLIFIER
- AMPLIFIER
- TO BACK END

- 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
SINGLE-KNOB TUNING

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

PRE- SUPERHETERODYNE

SUPRHERETERODYNE

ARMSTRONG & THE SUPERHETERODYNE

http://www.geocities.com/nevyakov/electro_science/armstrong.html
\[
\cos(\omega_L t) \cos(\omega_R t) = \frac{\cos[(\omega_R - \omega_L) t]}{2} + \frac{\cos[(\omega_L + \omega_R) t]}{2}
\]

\[
\cos(\omega_L t) \sum_R A_R \cdot \cos(\omega_R t) = \\
\sum_R \frac{A_R \cdot \cos[(\omega_L - \omega_R) t]}{2} + \sum_R \frac{A_R \cdot \cos[(\omega_L + \omega_R) t]}{2}
\]
FILTER:
1 MHZ BANDWIDTH
EXAMPLE
POWER METER
READS -114dBm
i.e. $10^{-11.4}$ mW.

RESISTOR AT
290 DEG.K
(17 DEG C)
POWER = $kT1$
POWER = $kT2$
FILTER:
BANDWIDTH = B
R @ T1
R @ T2

WHITE NOISE PRODUCED BY RESISTORS

S_in
Gamp
S_out = $G S_{in} + G kT_{amp}$
IMAGINARY RESISTOR
AT TEMPERATURE
Tamp

AMPLIFIER WITH EQUIVALENT NOISE SOURCE
NOISE ANALYSIS FOR CASCADED AMPLIFIERS

T_1 \cdot G_1 \cdot G_3 + T_2 \cdot G_2 \cdot G_3 + G_1 G_2 G_3 = (T_1 + T_2/G_1 + T_3/G_1 G_2 ) \cdot G_1 G_2 G_3

EQUIVALENT AMPLIFIER

NOISE ANALYSIS FOR CASCADED AMPLIFIERS

FINDING THE NOISE TEMPERATURE OF AN ATTENUATOR

\[ T_{attn} = T_{phys}(1/G_{attn} - 1) \]

ATTENUATOR AT PHYSICAL TEMPERATURE \( T_{phys} \)

RESISTOR AT PHYSICAL TEMPERATURE \( T_{phys} \)

\[ P_{out} = kT_{phys} G_{attn} + kT_{attn} G_{attn} \]
Noise Figure - Alternate way to express the internal noise of an amplifier:

\[ NF_{amp} = \frac{290 + T_{amp}}{290} = 1 + \frac{T_{amp}}{290} \]

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 Pertti Hakonen
Helsinki University of Technology.

NRAO 100 GHz 75-110 GHz

LOW-NOISE AMPLIFIERS

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

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