System Noise Temperature

Consider first the noise representation of the antenna and the *low noise amplifier* (LNA) shown in Fig. 2.15. The available power gain of the amplifier is denoted as *G*, and the noise power output, as P_{no}.

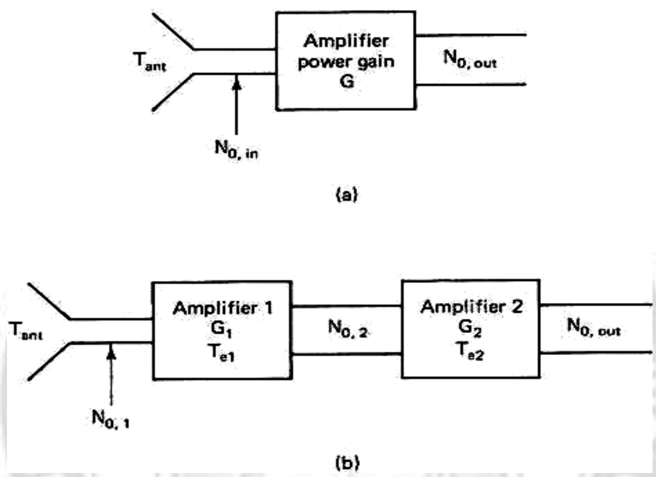

Fig 2.15 LNA Amplifier Gain

For the moment, the noise power per unit bandwidth, which is simply noise energy in joules as shown by the following Equation. The input noise energy coming from the antenna is

$$N_{0,ant} = kT_{ant}$$

2.8.1 The Uplink

The uplink of a satellite circuit is the one in which the earth station is transmitting the signal and he satellite is receiving it t specifically that the uplink is being considered.

$$\frac{C}{N} = [EIRP] - [LOSSES] + [k]$$

In the above equation, the values to be used are the earth station EIRP, the satellite receiver feeder losses, and satellite receiver *G*/*T*. The free-space loss and other losses which are frequency-dependent are calculated for the uplink frequency.

2.8.2 Input back-off

Since the number of carriers are present simultaneously in a TWTA, the operating point must be backed off to a linear portion of the transfer characteristic to reduce the effects of inter modulation distortion. Such multiple carrier operation occurs with *frequency- division multiple access* (FDMA). The point to be made here is that *backoff* (BO) must be allowed for in the link-budget calculations. Suppose that the saturation flux density for single-carrier operation is known. Input BO will be specified for multiple-carrier operation, referred to the single- carrier saturation level.

The earth-station EIRP will have to be reduced by the specified BO, resulting in an uplink value of $[EIRP]_U = [EIRP_S]_U + [BO]_i$

2.8.3 The earth station HPA

The earth station HPA has to supply the radiated power plus the transmit feeder losses, denoted here by TFL, or [TFL] dB. These include waveguide, filter, and coupler losses between the HPA output and the transmit antenna. The earth station may have to transmit multiple carriers and its output also will require back off, denoted by $[BO]_{HPA}$. The earth station HPA must be rated for a saturation power output given by

$$[P_{HPA,sat}] = [P_{HPA}] + [BO]_{HPA}$$

2.8.4 Downlink

The downlink of a satellite circuit is the one in which the satellite is transmitting the signal and the earth station is receiving it. Equation can be applied to the downlink, but subscript D will be used to denote specifically that the downlink is being considered.

$$\frac{C}{N} = [EIRP] - [LOSSES] + [k]$$

In the above equation, the values to be used are the satellite EIRP, the earth- station receiver feeder losses, and the earth-station receiver G/T. The free space and other losses are calculated for the downlink frequency. The resulting carrier-to-noise density ratio appears at the detector of the earth station receiver.

2.8.5 Output back-off

Where input BO is employed as described in a corresponding output BO must be allowed for in the satellite EIRP. As the curve of Figure 2.16 shows that output BO is not linearly related to input BO. A rule of thumb, frequently used, is to take the output BO as the point on the curve which is 5 dB below the extrapolated linear portion. Since the linear portion gives a 1:1 change in decibels, the relationship between input and output BO is $[BO]_0$ $[BO]_i$ 5 dB. For example, with an input BO of $[BO]_i$ 11 dB, the corresponding output BO is $[BO]_0$

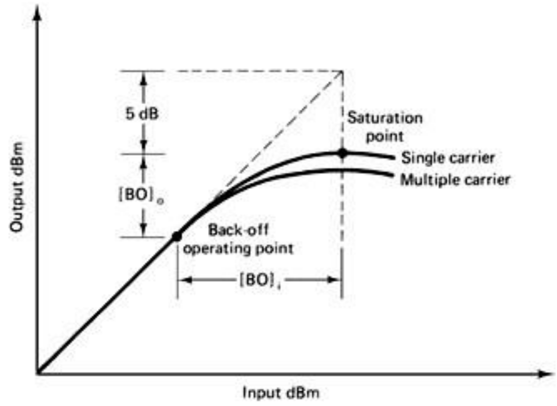

Fig 2.16 Input and output back- off relationship for the satellite traveling-wave-tube amplifier