1. The RC transmitter for your new drone operates at 2.4GHz, with a transmit power of 1.5W. Both the transmitter and the receiver are equipped with half-wave dipole antennas (gain of 1.64 absolute). The receiver on the drone must receive at least 150pW of power to remain in contact with the transmitter. Assuming the receiver electronics are maintained at a temperature of 300K and the signal has a bandwidth of 8kHz, determine the minimum SNR for this receiver.

$\text{SNR}_{min} =$ 4.53×10^6

$P_{\text{noise}} = k\,T_{\text{sys}}\,BW$
$= (1.38 \times 10^{-23})(300)(8 \times 10^3)$
$= 3.312 \times 10^{-17}$ W $= 33.12$ aW
The 150 pW it must receive is its sensitivity, $P_{R,\text{min}}$, and $P_{R,\text{min}} = SNR_{\text{min}} \cdot P_{\text{noise}}$:
$$SNR_{\text{min}} = \frac{P_{R,\text{min}}}{P_{\text{noise}}} = \frac{150 \times 10^{-12}}{3.312 \times 10^{-17}} = 4.53 \times 10^6$$
The frequency, the transmit power and the antenna gains are not needed.

2. The receiver on a search and rescue HC-130 requires a signal-to-noise ratio of 7.5 to detect and process a signal. If the voice mode of a survival radio uses a bandwidth of 16 kHz, what is the minimum received power needed by the HC-130? (Assume that Tsys=300)

$\text{P}_{received} =$ $497aW$

$P_{\text{noise}} = k\,T_{\text{sys}}\,BW$
$= (1.38 \times 10^{-23})(300)(16 \times 10^3)$
$= 6.624 \times 10^{-17}$ W $= 66.24$ aW
$P_{R,\text{min}} = SNR_{\text{min}} \cdot P_{\text{noise}} = (7.5)(66.24\text{ aW})$
$= 496.8$ aW ≈ 497 aW

3. The receiver of an air-surveillance RADAR has a system noise temperature of 650 K and a bandwidth of 3.2 MHz. The echo from a distant aircraft arrives at the receiver with a power of 52.5 fW. The RADAR needs a signal-to-noise ratio of at least 1.5 to detect a target.

(a) What is the receiver's noise power? P_{noise} = 28.7 fW

$P_{\text{noise}} = k\,T_{\text{sys}}\,BW$
$= (1.38 \times 10^{-23})(650)(3.2 \times 10^{6})$
$= 2.8704 \times 10^{-14}$ W $= 28.70$ fW

(b) What is the SNR of the echo? SNR = 1.83

$$SNR = \frac{P_R}{P_{\text{noise}}} = \frac{52.5 \text{ fW}}{28.70 \text{ fW}} = 1.83$$

(c) Does the RADAR detect the aircraft? Detected? Yes

$SNR = 1.83 \geqslant SNR_{\text{min}} = 1.5$: yes, detected
The same test as a power:
$P_{R,\text{min}} = SNR_{\text{min}} \cdot P_{\text{noise}} = (1.5)(28.704 \text{ fW})$
$= 43.06$ fW, and 52.5 fW $\geqslant$ 43.06 fW