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SUBJECT : Radar and S. communication

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Question No #02

Sol:

(A) Given:

$d = 3m$

$f_1 = 8\,GHz$

$f_2 = 14\,GHz$

Solution:

$$g = \eta_A \left(\frac{\pi d}{\lambda}\right)^2$$

$$g = \eta_A \left(\frac{\pi d}{\frac{c}{f}}\right)^2 \quad \text{where } \lambda = \frac{c}{f}$$

$c = 3\times10^8\ m/s$

$$g = \eta_A \left(\frac{\pi f d}{c}\right)^2$$

$$g = \eta_A \frac{\pi^2 f^2 d^2}{c^2}$$

$$= \frac{(3.14)^2}{(3\times10^8)^2} \times f^2 d^2 \eta_A$$

$$= \frac{9.8596}{9\times10^{16}} \times f^2 d^2 \eta_A$$

$$g = 109.55 \times f^2 d^2 \eta_A$$

to find Gain in DB

$G = 10 \log (109.55 \times f^2 d^2 \eta_A)$

As we know $\eta_A = 0.55$, $d = 3m$

So for f_1

$G_1 = 10 \log (109.55 \times (8)^2 \times (3)^2 \times 0.55)$

$G_1 = 10 \log (34705.44)$

$G_1 = 45.40 \text{ dBi}$

For $f_2 = 14 \text{ GHz}$

$G_2 = 10 \log (109.55 \times (14)^2 \times (3)^2 \times 0.55)$

$= 10 \log (106285.41)$

$G_2 = 50.26 \text{ dBi}$

(B) Find

$A_e = ?$

gain $= 46$

$f = 12 \text{ GHz}$

$\eta_A = 0.55$

(3)

We know from Gain formula

$G = 10 \log (109.66 \times f^2 \times d^2 \times \eta_A)$

$46 = 10 \log (109.66 \times (12)^2 \times d^2 \times 0.55)$

$46 = 10 \log (8685.072 d^2)$

$46 = \log (86850.7 d^2)$

taking antilog on both sides

$8685.072\, d^2 = 10^{4.6}$

$d^2 = \frac{10^{4.6}}{8685.072}$

$d^2 = 4.5838$

$d = 2.14\, m$

We know $A_e = \eta A$

Where $A = \frac{\pi d^2}{4}$

$A = \frac{3.14 \times (2.14)^2}{4}$

Scanned with CamScanner

$A = 3.59\ m^2$

so $A_c = (0.55)(3.59)$

$A_c = 1.977 m^2$

Question NO # 03

Sol:

ξ = 760 km

Service Link frequency = 1.6 GHz

feeder k" UL = 29.7 GHz

feeder " DL = 19.5 GHz

Find:

L_{FS} = ?

$L_{fs}(UL)$ = ?

$L_{fs}(DL)$ = ?

We know that formula for LFs as

$$L_{Fs} = 20\ Log(f) + 20 Log(\xi) + 92.44$$

$$L_{Fs} = 20\ Log(1.6) + 20 Log(760) + 92.44$$

$$= 4.0823 + 57.6162 + 92.44$$

$$\boxed{L_{Fs} = 1.54.1385\ dB}$$

$$L_{Fs}(DL) = L_{Fs} + 20 Log(F_4/F_5)$$

$= 154.1385 + 20 Log \left(\frac{29.24\ GHz}{1.6\ GHz}\right)$

$= 154.1385 + 20 Log (18.275)$

$= 154.138 + 25.23$

$\boxed{LFs_{(UL)} = 179.3685\ dB}$

$LFs_{(DL)} = LFs + 20 Log (Fd/Fs)$

$= 154.1385 + 20 Log \left(\frac{19.5\ GHz}{1.6\ GHz}\right)$

$= 154.1385 + 21.718$

$\boxed{LFs_{(DL)} = 175.8565}$

Question NO # 04

Sol:

We have to find the transmitted power P_t, As we know for VSAT network

$$\left(\frac{C}{\eta_0}\right) = \left(\frac{\eta_t \eta_r A_t A_r}{L_0 k}\right)\frac{P_t}{\lambda^2 S^2 T_s} \rightarrow (1)$$

Given data

$\eta_t = 0.65$

$\eta_r = 0.55$

$\rho = 35900$ km

$d_t = 32$ m

$d_r = 1.2$m

$k = 1.39 \times 10^{23}$ J/K

$T_s = 400$k

$f = 12.25$ GHz

$L_0 = 1.2$ dB

$$A_t = \frac{\lambda d^2}{4} \Rightarrow \lambda = \frac{(3.2)^2}{4}$$

$$\Rightarrow \frac{(3.14)(3.2)^2}{4}$$

$$\Rightarrow A_t = 8.038\, m^2$$

$A_r = \frac{\lambda d r^2}{4} \Rightarrow \frac{\lambda (1.2)^2}{4}$

$A_r = \frac{(3.14)(1.2)^2}{4}$

$A_r = 1.1304 \ m^2$

Also

$\lambda = c/f$

$\lambda = \frac{3 \times 10^8}{12.25 \times 10^9}$

$\boxed{\lambda = 0.024 m}$

$L_o = 1.2 dB$

$L_o = 10^{\frac{1.2}{10}}$

$L_o = 1.318$

$\frac{C}{N_o} = 55 \ dBHz$

$\frac{C}{\eta_o} = 10^{5.5}$

$\frac{C}{\eta_o} = 316227.76$

From eq (1)

pt can be written as

$$pt = \left(\frac{c}{\eta o}\right)\left(\frac{\lambda^2 r^2 t_s t_o k}{\eta^t \eta^r A_t A_r}\right)$$

$$\Rightarrow (316227.76 \times (0.024)^2 (35900)^2 \times 400 (1.318)(1.39 \times 10^{-23}) / (0.65)(0.55)(1.1304)(8638$$

$$\Rightarrow \boxed{pt = 5.295 \times 10^{-10}\ W}$$

Q5) Given below are the specification of a Radar system and a target which this Radar will attempt to detect :

Solution :

Given data :

Transmitted power 2MW
Antenna gain 3000
Antenna effective aperture $15m^2$
Transmit frequency 1.27GHz
Transmit pulse width 2.5 μs
pulse repitition frequency 350pps
Receiver noise factor is 3

Target specification :

Rcs is $1m^2$
Range from Radar is 350nmi

1)

$ERP = P_T \cdot G_T$ — (1)

Putting values in eq (1)

$ERP = 2000000 \times 3000$

$= 6000,000,000W$.

2)

We know that

$$P/_{AF} = \frac{P_T}{4\pi R_T^2 / G_T^2} \quad —(2)$$

350 nmi equals to 648200 m

so

$$A = 4\pi r^2$$
$$= 4(3.14)(648200)^2$$
$$= 5.28 \times 10^{12}$$

Radar cross section $10 m^2$

$$\frac{1}{3000} \times 5.28 \times 10^{12}$$

$$= 1760000000 m^2$$

The total transmitted power is 2000000

$$2000000 / 1760000000$$

$$= 0.001136 \ w/m^2$$

Directed formula of

$$P/_{AF} = 2000000 \times 3000 / 4(3.14)(648200)$$

$= 6000{,}000{,}000 / 7.536 \times 10^{10}$

$= 0.0796$

3)

$$P_{Tgt} = \frac{P_T G_T \sigma}{4\pi R_T^2} \quad \frac{1}{4\pi R_e^2}$$

$$P/_{AB} = P_{Tg} + \frac{1}{4\pi R_e^2}$$

$$= 0.001136 \times \frac{1}{4(3.14)(648200)^2}$$

$$= 2.153 \times 10^{-16}\ w/m^2$$

4)

Effective area = $20m^2$
power density of Echo

$2.153 \times 10^{-16} \times 20$

$= 4.36 \times 10^{-15}\ Lo$

We can also write echo power as

$$P_\sigma = P_T G_T \sigma A_E / (4\pi)^2 R^4$$

Above in simplified version of radar equation but it ignore all lossess

$$P_R = \frac{k_R 6}{R^4 L_A}$$

$$k_R = P_T G_T A_E / (4\pi)^2 L_s$$

$$k_R = P_T G_T^2 \lambda^2 / (4\pi)^3 L_s$$

$$k_R = (2000000)(3000)(20) / 4(3.14)(1)$$

$$= 9.42 \times 10^{10}$$

$$k_R = 9.4 \times 10^{10}$$

$$P_R = \frac{k_R 6}{R^4 L_A}$$

$$= 9.42 \times 10^{10} \times 3 / 648200$$

$$= 4.78 \times 10^{-14} \, w \text{ Ans.}$$

Q1) Answer the following questions.

a) Is there any difference between backscatter and clutter. If Yes then briefly discuss it?

Answer:

Backscatter:

Backscatter is the portion of the outgoing radar signal that the target redirects back towards the radar antenna.

If the signal formed by backscatter is undesired it is called clutter.

b) A Radar system may receive multiple forms of interference signals so what can be those types of Interfacing signals discuss any three of them.

~~Intermodulation~~ In tele-commonication an interface is that which modifies a signal in a descriptise manner as it travel along a commonication channel between its source and recever.

TYPES

1) Radio Frequency interfarance:

This type of interferance is caused by a radio frequency (RF) signal on or near the frequency of the effected wireless receiver the interfering signals might have been transmitted.

2) Electrical Interferance:

Electrical interferance does not benifit anyone and its almost never intentional.

3) Intermodulation:

Intermodulation is intermodulated type of interferance some times encontured in wireless.

$C/N_0 = 10^{5.5}$

c) Discuss both range resolution and Doppler resolution. How come they are important in target detection on the basis of their basic criteria?

Ans)

In telecommunication an interface is that which modifies a signal in a disruptive manner as it travel along

Range Resolution:

Range resolution is the ability of a radar system to the distinguish between two or more target on the same bearing but at different ranges the degree of the range resolution depend on width of the transmitted pulse.

$$\delta r = \frac{c_0 \cdot \tau_{PW}}{2} \; [m]$$

Doppler resolution:

Doppler resolution usually depends on the dwell time T_{dwell}, i.e, the time for which the radar is going to stare (look) at the target. If the pulse / sweep repetition interval is given by T_{PRI} then $N = T_{dwell}/T_{PRI}$ is the number of pulse / sweeps in one dwell.