Antenna Feed Efficiencies – Steps showing computation

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1 Step 1 :

The XY plot record of the relative power of the feed under test vs. the angle of rotation (normal to the plane of measurement) is digitised first.

2 Step 2 :

The y –axis values in mm. are converted to power-level values by feeding–in the calibration values of the detector and log–amplifier i.e., mm.→ dBm.

3 Step 3 :

For a given configuration of the feed under test and the test frequency used for measurement, the E– and H– plane pattern values are recorded in a data file.
The order of recording is : Pattern values (in mm.) for positive angles, followed by negative angles.
`[ Note: Angluar values are not stored in the data file; for a given interval , it is computed in the Efficiencies program ]`

4 Step 4 :

If ψ_i denotes the angle (of rotation) where $\psi_i = 0$ when $i = 1$, and $E(\psi_i)$, $H(\psi_i)$ are the power levels measured at ψ_i for the E– and H– planes respectively, the voltage levels are computed as follows :

$$
\begin{aligned}
E_v(\psi_i) &= 10^{-E(\psi_i)/20} \\
H_v(\psi_i) &= 10^{-H(\psi_i)/20}
\end{aligned}
$$

5 Step 5 :

The co–polar and cross–polar patterns are computed next, using the following equations (assuming the principal plane patterns [viz. E & H] are symmetric w.r.to ψ_i):

$$
\begin{aligned}
CO(\psi_i) &= \frac{1}{2}\cdot[E_v(\psi_i) + H_v(\psi_i)] \\
XP(\psi_i) &= \frac{1}{2}\cdot[E_v(\psi_i) - H_v(\psi_i)]
\end{aligned}
$$

6 Step 6 :

The following integrals are evaluated next, where Ψ_0 is the semi rim–angle of the parabolic dish :

$$T_1 = \int_0^{\Psi_0} \left[|CO(\psi)|^2 + |XP(\psi)|^2\right]\cdot\sin\psi d\psi \tag{1}$$

$$T_2 = \int_0^{\pi} \left[|CO(\psi)|^2 + |XP(\psi)|^2\right]\cdot\sin\psi d\psi \tag{2}$$

$$T_3 = \int_0^{\Psi_0} |CO(\psi)|^2 \sin\psi d\psi \tag{3}$$

$$T_4 = \int_0^{\Psi_0} |CO(\psi)| \tan\left(\frac{\psi}{2}\right) d\psi \tag{4}$$

$$T_5 = \int_0^{\Psi_0} CO(\psi) \tan\left(\frac{\psi}{2}\right) d\psi \tag{5}$$

7 Step 7 :

The sub–efficiencies as given by Kildal.P.S.[1]
, are primarily four in numbers,viz., (i). Spill–over efficiency η_{sp}, (ii). Polarization efficiency η_{pol}, (iii). Illumination or Taper efficiency η_{tr} and (iv). Phase efficiency η_{ϕ}.In terms of the

[1] Kildal.P.S.,Factorization of the Feed Efficiency of Paraboloids and Cassegrain Antennas, IEEE Trans.on Antennas & Propagation, Vol.AP-33,1985, pp.903--908.

above integrals (1) to (5), the sub-efficiencies are given by:

$$\eta_{sp} = \frac{T_1}{T_2} \tag{6}$$

$$\eta_{pol} = \frac{T_3}{T_1} \tag{7}$$

$$\eta_{tr} = 2\left(\cot^2\frac{\Psi_0}{2}\right)\cdot\frac{{T_4}^2}{T_3} \tag{8}$$

$$\eta_{\phi} = \frac{|{T_5}^2|}{{T_4}^2} \tag{9}$$

The Overall feed efficiency (assuming no losses due to blockage,surface errors, leakage thro' reflector mesh etc...), η_F

$$\eta_F = \eta_{sp}\cdot\eta_{pol}\cdot\eta_{tr}\cdot\eta_{\phi} \tag{10}$$

All the above relations were implemented in a program titled `EFXYPL.BAS` (written in GW–BASIC).

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