Design procedure of circular patch antenna :

Based on the cavity model formulation, a design procedure of circular patch antenna for the dominant TM^z_{110} mode is as follows :

1. Specify ϵ_r, f_r (in Hz), h (in cm)
2. Find the effective radius

$$a_e = \frac{8.791 \times 10^9}{f_r \sqrt{\epsilon_r}}$$

3. Find the actual radius of the patch

$$a = \frac{a_e}{\sqrt{1 + \frac{2h}{\pi \epsilon_r a_e}\left[\ln\left(\frac{\pi a_e}{2h}\right) + 1.7726\right]}}$$

Problem :-

Design a circular microstrip antenna using a substrate (RT/duroid 5880) with a dielectric constant of 2.2, $h = 0.1588$ cm (0.0625 inche) so as to resonate at 10 GHz.

ANS :-

$$a_e = 0.593 \text{ m}$$

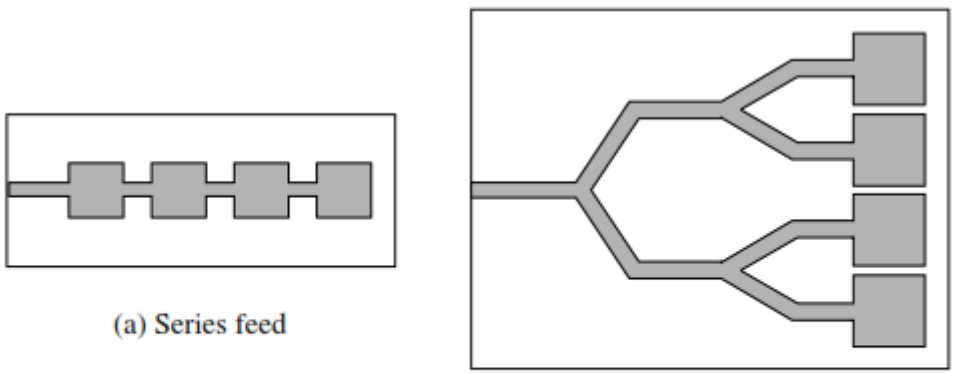
$$a = 0.525 \text{ cm } (0.207 \text{ in})$$

ARRAYS AND FEED NETWORKS :

Arrays are used to scan the beam of an antenna system, increase directivity and Perform various other functions which would be difficult with one single element.

The elements can be fed by two methods

1. Series Feed
2. Corporate Feed



(a) Series feed

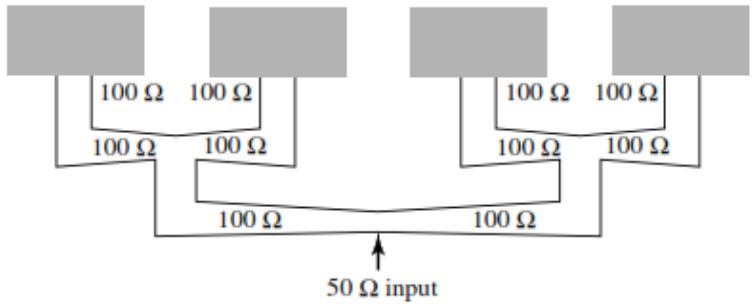
(b) Corporate feed

Figure 14.36 Feed arrangements for microstrip patch arrays.

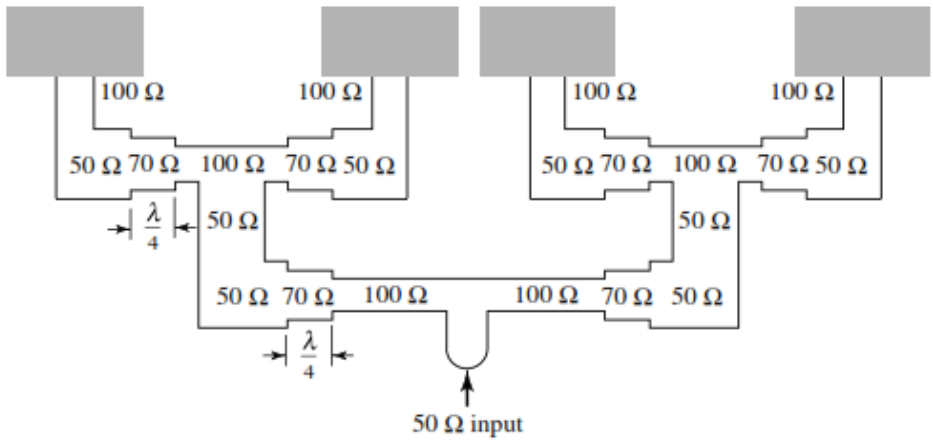
In series Feed, the elements are fed by a single line and in corporate feed, the elements are fed by multiple lines in a Feedback Network arrangement.

corporate feed Network is used to provide power splits of 2^n. This is accomplished by using either tapered lines to match 100Ω Patch

elements to a 50Ω input or using Quarter wavelength impedance transformer.



(a) Tapered lines



(b) λ/4 transformers

Figure 14.37 Tapered and λ/4 impedance transformer lines to match 100-ohm patches to a 50-ohm line. (SOURCE: R. E. Munson, "Conformal Microstrip Antennas and Microstrip Phased Arrays," *IEEE Trans. Antennas Propagat.*, Vol. AP-22, No. 1, January 1974. © 1974 IEEE)

series feed arrays can be easily fabricated using photolithography for both radiating elements and the feed network. However, this technique is limited to arrays with a fixed beam or to the arrays which are scanned by varying the frequency but it can be applied to linear and planar arrays

with single or dual polarization. Also any changes in one of the elements or feed lines affects the performance of the others. Therefore while desiging mutual coupling and internal reflections have to be taken into account.

corporate fed arrays are general and versatile. with this method, the designer has more control of the feed of each element (amplitude and phase) and it is ideal for scanning phased arrays, multibeam arrays or shaped - beam arrays.

In corporate fed arrays, the phase of each element can be controlled using phase shifters and amplitude can be adjusted using either amplifiers or attenuators.

An electronically steered phased array of 10 x 10 rectangular microstrip elements operating in 2-2.3 GHz frequency range and used for space-to-space communications is shown in figure below.

In microstrip arrays, radiation from the feed line, using either a series or corporate feed network, cross polarisation takes place and also

limits the side lobe level.

Both cross polarization and side lobe levels can be improved by isolating the feed Network from the radiating face of the array. This can be accomplished using either probe feeds or aperture coupling.

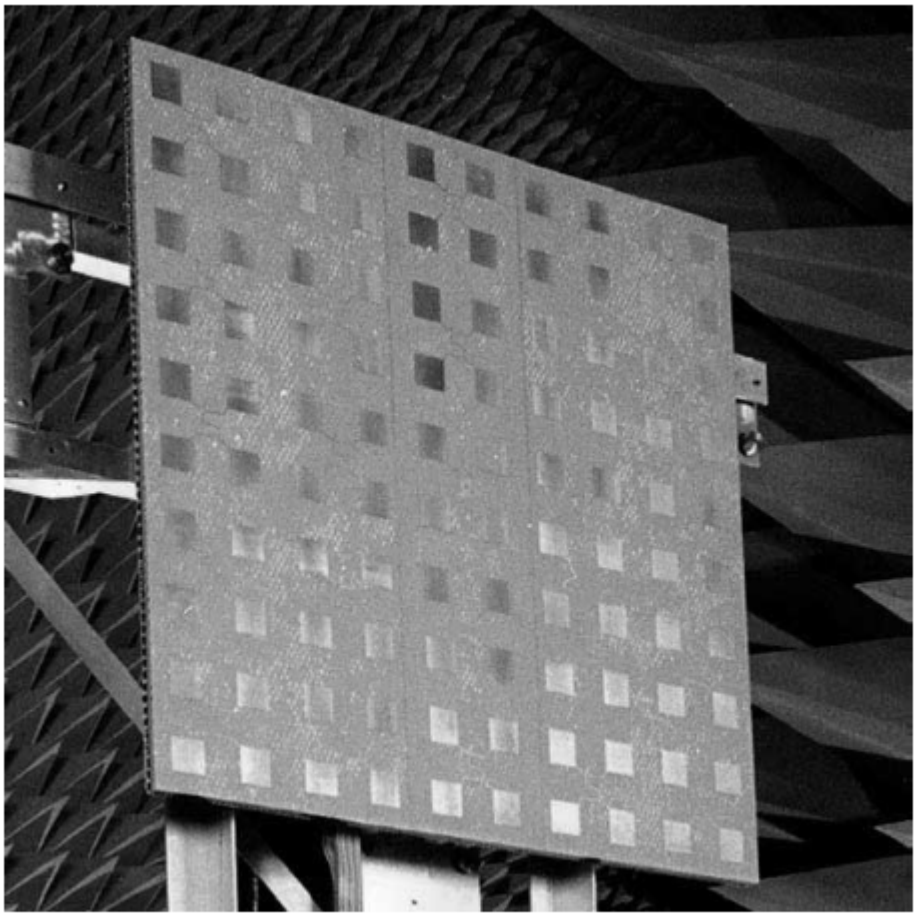


Figure 14.38 Antenna array of 10×10 rectangular microstrip patches, 2–2.3 GHz, for space-to-space communications. (Courtesy: Ball Aerospace & Technologies Corp.)