OMNIDIRECTIONAL ANTENNA USING LINEAR ARRAYS

OF PATCHES FOR 17GHz BAND

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ABSTRACT

An omnidirectional antenna for wireless indoor communications in 17GHz band is presented in this work. The antenna architecture uses a hexagonal arrangement of six three unequal size patches fed by microstrip through slots. The arrays are excited through 90º transitions using an almost symmetrical one-to-six microstrip power divider fed by a SMA connector. A gain of around 6dB with 1dB ripple in azimuth in the frequency band of interest (200MHz) and a 10dB return loss bandwidth of 1GHz have been measured.

INTRODUCTION

Advantages of microstrip antennas, as lightweight, low cost and relatively easy manufacture are widely known [1]. From an antenna performance point of view, additional benefits are obtained by using aperture feeding techniques [2]. These structures provide isolation from feeding network spurious radiation and facilitates feeding network design. Their main drawback is the inherent narrow band behaviour.

Several aperture coupled linearly polarised microstrip antenna designs for 17GHz WIND-FLEX project have been recently presented [3]. WIND-FLEX (Wireless INDoor FLEXible High Bitrate Modem Architecture) project is developing a 100 Mbit/s modem for Wireless indoor network use in the 17GHz band. For this application, a 200MHz bandwidth is required which is about a 1.2% bandwidth that can be reached easily with the antennas proposed. These antennas were designed using relatively thin dielectrics and both microstrip and CPW fed systems. They had a directional nature.

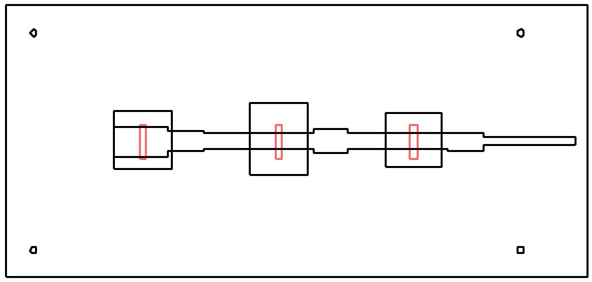
However, the lack of base stations in the network forces the use of omnidirectional antennas for each individual node. To fulfil this requirement and using as a starting point the designs already carried out, which had approximately 80 degrees beamwidth in azimuth, a hexagonal arrangement of six basic antennas could be used to provide omnidirectional coverage. The idea of obtaining a low cost antenna precludes the use of individual fed so that a power divider must be used to feed the arrangement.

The next section summarises the steps followed to design the antenna and the results obtained for the first prototype.

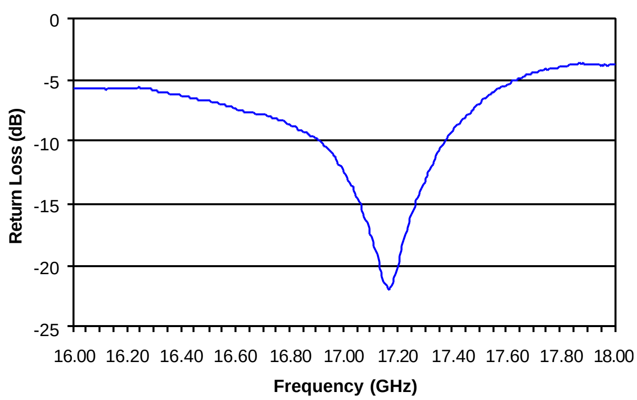
ANTENNA DESCRIPTION AND RESULTS

As it was stated before, the antenna concept was based on the use of a hexagonal arrangement made up of printed patches fed by slots excited with microstrip line and with only one access point. This problem can be solved by using a printed almost symmetric one-to-six power divider to guide the signal from a SMA input connector to 90º transitions used to couple the signal to the antenna fed networks.

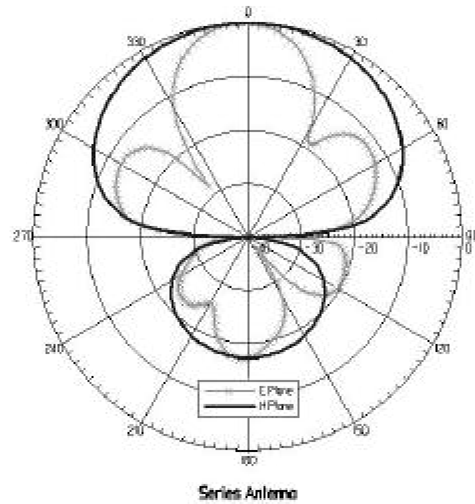
A first rough estimate for the gain requirements of the antenna elements can be obtained by considering an insertion loss of 8dB for the distribution network and 2dB for the 90º transition. If the aim is to achieve a gain of around 4dB, the antenna elements must provide approximately 14dB gain. Having this in mind, linear arrays of patches were designed with the help of Ensemble simulator. A three unequal patches array with an element spacing of approximately 0.7 wavelengths provided the desired characteristics. It was tuned up with the help of Agilent´s HFSS. These elements were manufactured and measured. Input impedance results are shown in Fig. 1(b) along with a schematic of the geometry (Fig. 1(a)).



(a)



(b)



(c)

Fig. 1. (a) Schematic of the linear array elements. (b) Typical results for the measured return losses. (c) E and H plane simulated field with Ensemble

Return losses lower than 10dB where obtained over the whole band of interest. Six elements where built and tested individually and similar results where obtained in all cases. The simulated radiation patterns with Ensemble for the E and H planes are shown in Fig. 1(c). The small shift in elevation was corrected with the help of the finite element tool. Measurements of 3dB beamwidth in an small anechoic chamber with a rudimentary alignment system and with the help of a 20dB gain horn provided values of around 80 degrees in azimuth, which matched simulations closely. The same system was used to measure the gain and results of around 14dB were obtained which agreed with simulations within 0.5dB. This 80º beamwidth was considered to minimise gain ripple in the final prototype.

The 90º transitions where simulated with the help of the commercial 3D simulator and experimentally verified by manufacturing several isolated 90º transitions and 90º transitions with a basic element as load. Scattering parameter measurements proved more than acceptable conformity with simulations and bibliography [4], encouraging its use in an omnidirectional prototype: 1-1.5dB transmission losses and low matching degradations were found.

An asymmetric one-to-six power divider was designed to feed the arrangement from the SMA coaxial port. A scheme of the divider is shown in Fig. 2. Special attention was given to obtain equal power and phase for each output port during the design. Wilkinson power dividers were not used due to the lack of space. Insertion loss measurements where performed by matching ports and results were of around 3.8dB for all ports within the band of interest with almost equal phase for all ports. With all elements checked individually, the assembly of the structure was carried out.

The final prototype was built by placing the power divider on a platform with a SMA connector. The arrays where welded to this platform with a precise alignment and their ground planes were welded along the sides to ensure ground continuity between them. Finally, the 90º transitions were carried out for each element and a top cover was used to provide rigidity to the antenna. The resulting prototype is shown in Fig. 3 where its compact self-supporting structure can be observed .

Measurements of this antenna were carried out and are presented in this paragraph. First of all, return loss results are shown in Fig. 4 where a good matching (about 15dB) can be noticed for the band of interest. Fig. 5 shows the measured mean gain on the horizontal plane around the design frequency. It must be remembered here that the measuring method was very rudimentary so that results must be considered as a first approximation. In any case, values 2 or 3 dB higher than expected were obtained. This can be partially explained by the improved results of the prototypes with respect to initial estimates. Finally, Fig. 6 shows the measured gain ripple in the horizontal plane at 17.2GHz. A 2dB ripple around a mean value slightly lower than 6dB was obtained.

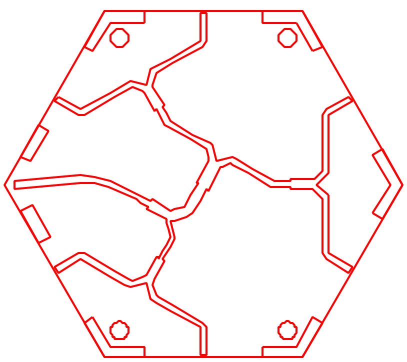


Fig. 2. Schematic of the six-to-one power divider

Fig. 3. Antenna prototype

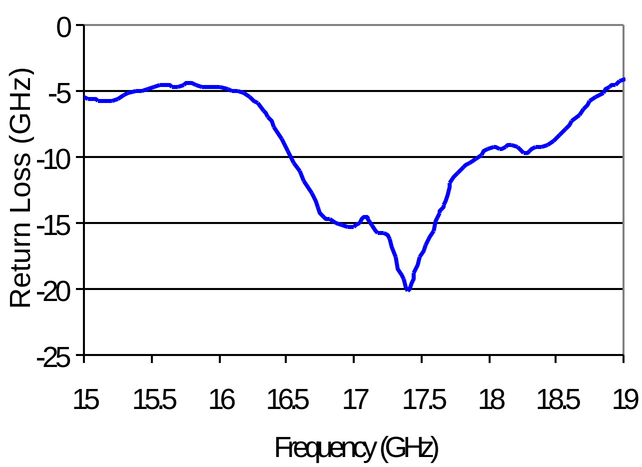


Fig. 4. Measured return loss of the prototype.

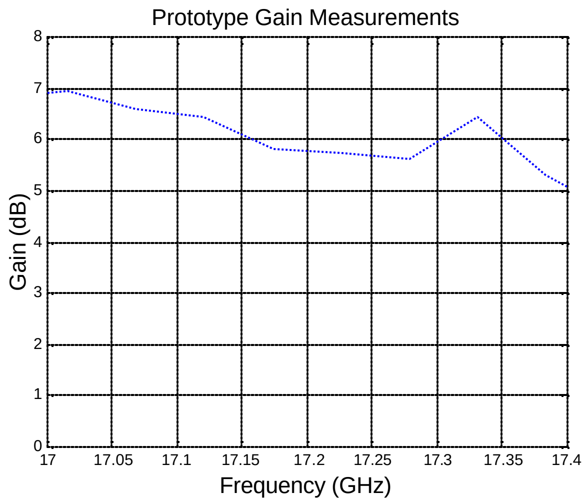


Fig. 5. Measured mean gain in the maximum plane as a function of frequency.

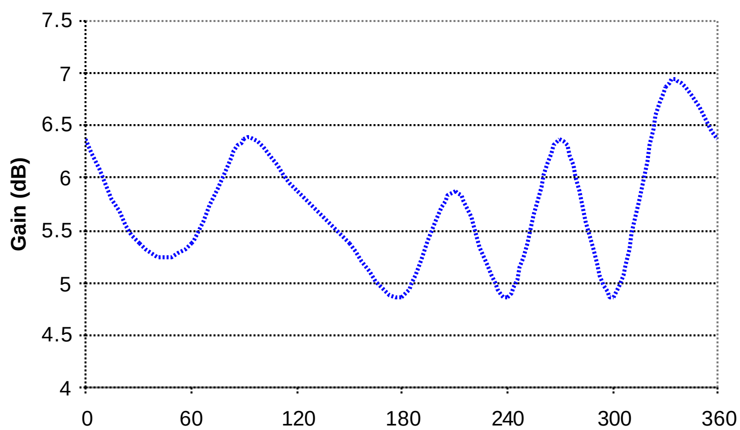


Fig. 6. Prototype radiation pattern for the horizontal plane

CONCLUSIONS

As conclusion we can remark that an omnidirectional antenna architecture has been proposed using aperture fed microstrip arrays as basic element. More than acceptable 15dB matching is found for required 17.2GHz central frequency, 200 MHz bandwidth. Omnidirectional behaviour within 2dB has been obtained as well as a gain of around 6dB.

ACKNOWLEDGEMENTS

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