Analysis and Design of Anchor Shape element for Broadband Reflectarray Antenna

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Abstract

This paper present an examination of phase deviation with phase range of slot loaded circle element of the broadband reflectarry antenna. By utilizing the physical geometry of the component shape. Less steep phase deviation and wider bandwidth enactment are achieved by adapting the current dissemination of the tradition circle component. The behavior of the element is investigated by discribtion and analyzing frequency response. The projected antenna component efficiently covers the frequency range of (8.44-10.78) GHZ in the x-band. Bandwidth broadening is realize by leading the slot loading of the component .The phase range is attained by using FR 4 (thickness = 1.524 mm) as the substrate. The idea of the slot loading initiates to broader bandwidth (up to 24.35 %) for the antenna and can apply to any x-band application.

تحليل وتصميم عنصر هوائي على شكل مرساة للنطاق الترددي الواسع لهوائي المصفوفة العاكسة

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المستخلص:

يقدم هذا البحث تصميم وتحليل لهوائي المصفوفة العاكسة باستخدام عنصر مشع شبيه بشكل مرساة السفينة لتطبيقات حزمة - X الترددية. لقد تم تحليل الهيكل الجديد ومقارنة النتائج مع عنصر الشكل الدائري التقليدي. ان الشكل الجديد يعطي مدى طوري جيد للتعويض عن تقلبات التردد الحاصلة بسبب تأخير الطور للفرق المكاني بين العناصر المتجاورة، وذلك من خلال الاستفادة من الهندسة الفيزيائية للعنصر. ان تعديل توزيع التيار لعنصر الدائرة التقليدية، يؤدي إلى تباين حاد للطور وكذلك أقل عرض النطاق الترددي. يغطي الهوائي المقترح نطاق الترددات من (٨,٤٤ غيغاهرتز إلى ١٠,٧٨ غيغاهرتز) في حزمة - X الترددية. ويتحقق من خلال توسيع فتحة

التحميل من العنصر. مفهوم فتحة التحميل يؤدي الى عرض النطاق الترددي على نطاق أوسع (تصل إلى ٢٤,٣٥٪) للهوائي ويمكن أن تطبق على أي تطبيق في حزمة - X الترددية.

1. Introduction

Reflectarray antennas are used in many applications due to its low profile, comprises the good features of array antennas and parabolic reflector antennas at the same time[1]. Ease of construction, beam shaping antenna applications and using reconfigurable radiation elements to design beam scanning antennas[2]. In reflectarray antennas a flat printed array of patch elements is fed by a horn antenna as an illumination source[3]. Whene each element intersects the incident wave and reflects it with a predesigned phase shift, a planar phase surface wave is formed forward the antenna aperture[4],this is shown in Figure 1. Total radiation pattern of the reflectarray be influenced by the element pollution pattern, array factor, and the source feed pattern[5]. Different methods are utilized to design efficient elements for reflectarray antennas, variable size patch antennas[6], microstrip patch antenna loaded with stubs[7], ring elements[8], aperture coupled patched antenna[9], and dipoles[10].

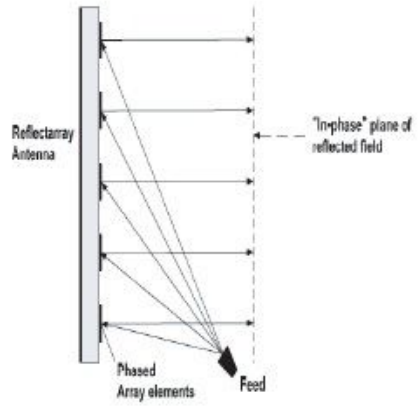


Fig. 1 reflectarray antenna layout.

By guiding the smattering belongings of every element, a plane wavefront is achieved[11]. The use of phase curves presents the core for reflectarray design.

Variable size method has been employed to manipulate the reflection phase of the microstrip patches[12]. In this method, phase changes of the reflected field results from small shifts in the resonant frequency of an element[13]. The flat aperture of the reflectarray collect and redirect the incident wave from a transmitter into the forge siron by proper phase changes through the shallow of the reflectarray[1].

Due to low-profile and small mass features of the microslip reflectarray,it is involved in many solicitations[14].the flat reflectarray can be fixed on a constructing side

hedge by means of Direct Broadcast Satellite (DBS) antenna[15]. Besides its can be fixed on the ridge of a van for satellite reception[3].

An intricstic narrow bandwidth characteristic is the main problem related to the reflectarray antenna, which is depends on its element flexibility, fed position, and reflectarray aperture size[1].The bandwidth of the published microslip reflectarray is restricted by two factors namely, the bandwidth limitation of printed radiating components, usually in order of 3–6%, and the phase delay of the incident pitch related to operating frequency[16]. The main obstacle can be avoided consuming heavier substrate or compound stacke d splotches, a 15 % or higher bandwidth has been achieved expending these methods[7]. another drawback can be solved using elements with single-layer printed patches of nonconventional shape[17].

2. Antenna Design Procedure

This paper projected a single element, namely circle element with two half square slots. Substrate FR-4, the dielectric constant of 4.3, with a thinness ($\boldsymbol{t = 1.524\,mm}$), the loss departure equal to 0.025 at 10 GHz, and with a copper thickness of 0.035 mm, is used. The item lockup majority is $\boldsymbol{10\,mm \times 10\,mm}$.To scrutinized the phase variant diagram, microwave software is used by means of the tool Figure 2 shows the geometry of the proposed element.

3. New Element Design And Behavior

The copper circular patch is an artless conductive proportioned component, which can be optimized for broadband operation[18]. The element size, periodicity and the electrical behavior of the substrate ingredients are used to conclude the resonant behavior of periodic array of circular element[19]. Circular patch produce 180° reflection phase at resonate condition[19].

The proposed element is a single circle element with two half square slots in this effort , as shown in Figure 2,is probed for phase variety, and likened to the sole circular component. Where L and R, are slot length and circle radius respectively.

To study the slot effect, the ratio of the slot length to the circle radius ($k = L/R$) was selected as follows 0.5, 0.75, 1, 1.25, and 1.5.

The maximum gain of the proposed element occurs at $k = ٠.٧٥$, when $f = ١٠.٥$ GHz as the resonant frequency that clear in figure 3.

Figure 4 (a) depicts the frequency response of the basic circle element with radius, R varies in the range of (1.5 mm to 3.5 mm), the initial value R= 3 mm (λ/10), and Figure 4 (b) for the new element at (k=0.75) with variable R.

By controlling the slot length variation (L) plus the circle radius (R), the required phase range is attained.

When R is static to basic value, the bandwidth is upgraded for lower values of slot size, L. In other words, the phase slope is condensed for the slighter ratio (K),that is obvious in figure 4(b).

also the linear phase range is requested, so a compromise between these two parameters should be taken into consideration[20]. a 180° phase reflection relative to the incident wave is recycled to delimit the resonance for a impeccable conducting patch[20].

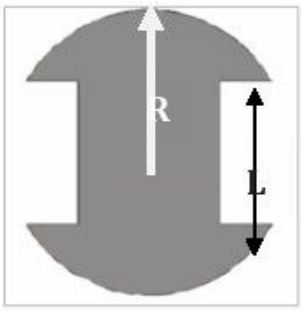
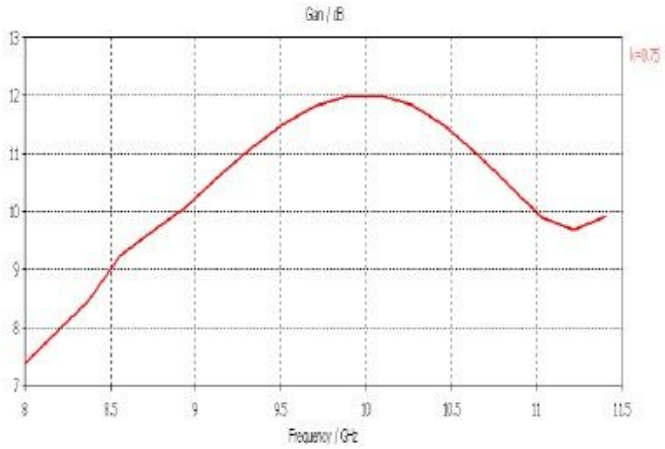
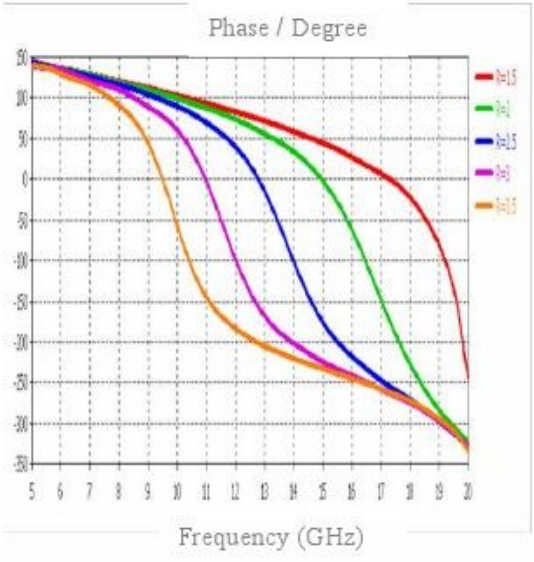
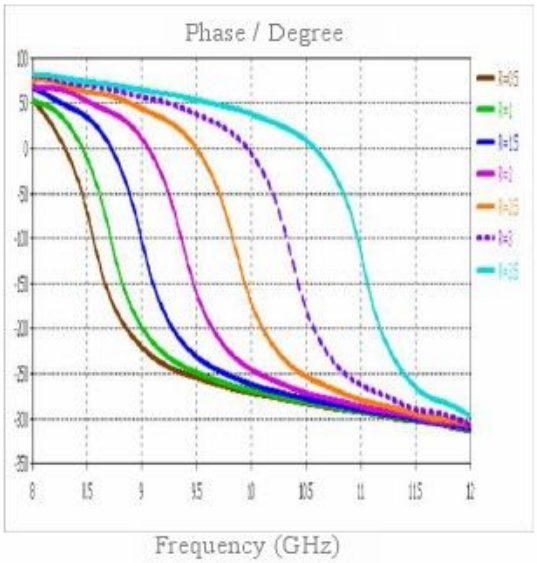


Fig. 2. The geometry of the projected element







(b)

Fig. 4. Frequency response for, (a) Circle component with differs R, (b) New component at (k=0.75) with differs R.

4. Results and Discussion

In previous section, the design with structural dimension is given.Frome figure.

(4),it is clear that the relation of simulated reflection phase with circle radius of the projected antenna is schemed at the resonant frequency of 10 GHz.Whears,phase range is 320° which is sufficient enough for practical design[21].

Same figure displays the Bandwidth performance for proposed component is 24.35 %. For the reason that the phase given at the higher R is not a tolerable resonance because the verge of the loop virtually touched the following episodic array element then triggered short-circuits, the maximum radius,(R) for the square ring is 4.46 mm as clear in fig.4.

٥. Conclusion

Several observations can be drawn from the results of this work:

- The suggested design of reflect array component is the slot loaded circle element for broadband twofold frequency X-band application.
- A better phase variation and wider bandwidth where have been obtained because of the adjusting current dissemination of the physical geometry of the constituent circle component.
- A good performance in bandwidth which is up to 24.35 % in the frequency of operation is obtained by this new design.
- The phase assortment of the component is also in a good practical expanse, which gives the value of 320°.
- The two features of this antenna, easy to manufacture and low cost are very advantageous for global portability of communication requests.

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