BANDWIDTH ENHANCEMENT OF A PRINTED SLOT ANTENNAWITH A PAIR OF PARASITIC PATCHES

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Abstract: *Slot antennas have long been an integral part of wireless systems and have been known for their robust, flat construction. Since its inception, there have been many developments. However, as new design concepts continue to emerge, difficulties remain. The main theme of this thesis is related to these difficulties and introduces new ideas for matrices and aperture element.*

The single polarization limit is the first barrier, especially for waveguide aperture ranges, which can very often produce only a single linear polarization. In both communication systems, dual polarity is crucial This is because the four radar channels (HH, HV, VH and VV) provide MIMO / variation and characteristic information and applications for radar. Some studies have used two sets of waveguides to create double polarization, one for polarization and the other. The matrix becomes a large and inefficient structure. Achieving double polarization with a single waveguide is great. However, there are not many examples of this design now in the general literature. In addition, many emerging communication systems aim to integrate multiband bipolarized slot components into a single waveguide slot.

Keyword : Slot antennas, dual polarity, MIMO

1.Introduction

The aperture element was developed in Britain in 1938 by Alan Plumlin [1] to create a useful antenna for VHF television transmissions. Since then, the aperture antenna has gained great popularity due to its installation on a flat conductor. Surface. The radiation pattern around the carrier dipole in space is considered to be electrically comparable to that of the aperture element (less than half the wavelength). Some of the advantages of aperture antenna are high efficiency, high power handling capacity, low focus, low loss, low weight and ease of manufacture. The number of technical and scientific articles on slot antennas is very high, not even in a single research. In the following sections, the basics of slot antennas are reviewed when using appropriately referenced instructions.

1.1. Overview of Slot Antennas

1.1.1. Slot Elements

A simple aperture antenna is a thin rectangular aperture cut into a metal ground plane that radiates from both sides. It has been featured in many classic textbooks, such as [2-3]. It is useful to consider the complementary image of the free space wired bipolar antenna - aperture as shown in Fig. 1.1. A slot antenna supports the surface magnetic flux (M), while the dipole wire antenna supports the current (J) on its surface. Hence the aperture antenna at the infinite ground plane (or at least as large as the electric one) has the same radiation properties as the dipole antenna. Also, aperture impedance and radiation patterns of the dipole antenna can be obtained through the Boker relationship [4]. However, as discussed in [5], the finite ground plane has a significant effect on the appearance and radiation characteristics of the aperture antenna. At the limited ground plane level, the aperture antenna has zero value in its design in the direction perpendicular to the aperture, while the dipole antenna is maximal (omnidirectional) in that direction. Also, due to the deflection of the edge from the limited ground plane, the gain from the aperture is greater than the wire dipole in the empty space. The bipolar half-wavelength is ideally about 2.1 dB, while the gain from the open aperture at half-wavelength at the finite earth level reaches 5.9 dB. As the ground plane size increases, the gain of the open aperture antenna decreases like a wire dipole.

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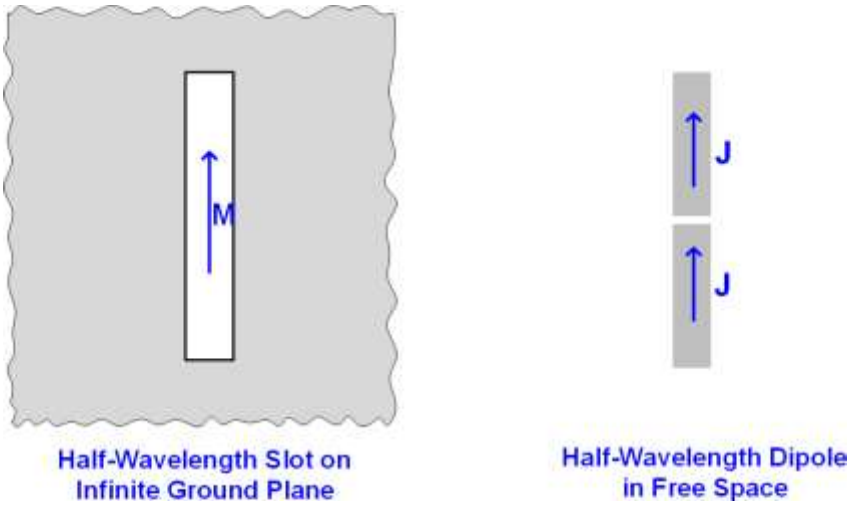

Figure 1.1A Narrow rectangular opening at infinite ground level (left) and complementary wire or dipole antenna in space. The current flowing along the bipolar wire is J amperes, or from a close angle, which is expressed as the current density in amperes / m 2; The magnetic flux in the hole is the same in volts or volts / m2. A lower current density on the planar conductor means that the hole has a higher radiation capacity than the dipole.

As complementary elements, the slot and dipolehavesimilarpotential bandwidths. However, the slot elementis easier to match and therefore can have alargermatched(to50) bandwidth. Patch antennas can be viewed and analyzed as radiating slots. Thepatch forms a resonant cavity and the open edges act as radiating slots. A significant advantage of the slot element over a patch element is its potentially wider impedancebandwidth. Single layer patch antennas usually have -10 dB S11 impedance bandwidth of just a few percent, and to expand the bandwidth typically requires the addition of parasiticstructures. An open slot (radiates both sides) antenna can easily achieve 20% -10 dB bandwidth without extra matching circuitry [5], and with a very wide slot width, thebandwidthcangettoabout40%.Foracavity-backed slot antenna (radiatesessentially to one side of the ground plane only) that is fed by50microstripacrosstheslot,abandwidthof43%hasbeenreported[6].Other technologies can also increase bandwidth, such as merging first and second resonance. The ribbon line-fed open aperture supports double resonance and 37% bandwidth is reported [7]. Another way to achieve broadband features is to combine a wide aperture with a tuning bit. Sze and Wang [8] proposed a microstrip line-fed, wide-aperture printed antenna with fork.
tuning stub, and a 1.5:1 VSWR bandwidth is reported to be over 50% (10 dB return loss bandwidth is more than 52%).Shafai*et.al.*studiedtheL-shapeopen-endslotantennaonagroundplane[9].TheL-shapeslotisfedbydifferentstriplines,whichappearstoexcitemultiple resonances in the slot, providing an impedance bandwidth of 87% while only occupying a small area ontheground plane.

The slot shape can be quite different from rectangular or L-shaped, such astaperedslots[10],circularslots[11],ringslots[12],crossedslots[13-18]foldedslots[19],fractalslots[20],dumbbellslot[21],andspiralslots[22].Withthesedifferentshapes,slotantennas can achieve different polarizations. For instance, a rectangular slot producesessentially pure linear polarization; and the crossed slot and ring slot can have two feeds with orthogonal linear polarizations with high isolation, and adding a phase-shiftingweightto one of the two orthogonal linear polarizations can generate almost any polarization (such asslantandcircularpolarizations).

A slot can be excited in several different ways. A coaxial line can be connectedacrossit [2], [5], see Figure1.2(a).At the secondresonance (definedwithazeroreactance) of a rectangular slot antenna, the resistance at the centre of the slot is around40. Therefore a direct connection provides a good broadband match to a 50 coaxialcable, and this use of the second resonance has been introduced relatively recently [5].Inrecentyears,manyworksaddressedthemicrostriplinefeed(asshowninFigure1.2b),astheyarelow-profile,easytofabricate,andintegratewithothercircuitcomponents.Theimpedance behavior of a microstripline-fed slot antenna was studied in, for example, [8],[9], [23]. Another way to feed slot antennas is the co-planar waveguide (CPW) (as shownin Figure 1.2c), which has the advantage that both the antenna and the CPW can beprinted on one layer. This property has made them ubiquitous, including popular wirelessapplications such as local area networks (WLANs) and Worldwide Interoperability forMicrowaveAccess (WiMAX)applications[24-

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25].

2.1. Crossed Slot Elements

Figure 2.1 depicts a cross-slot antenna in a limited ground plane. Due to the orthogonal arms at the crossing hole, two linear polarizations are available with excellent isolation. First, two asymmetric ports are considered to feed the jumper hole, as shown in Fig. 2.1. The 50 impedance voltage source acts as an excitation port.
Throughout the opening. Offset is a measure of the distance between the outlet and the center. The model simulation results in the CST microwave STUDIO® are shown in Figure 2.2.

Figure2.1. Thegeometryofacrossedslotantennafedbytwoasymmetricports. *a*=200mm, *L*=50mm,*w*= 5mm, *offset*= 12.5mm.

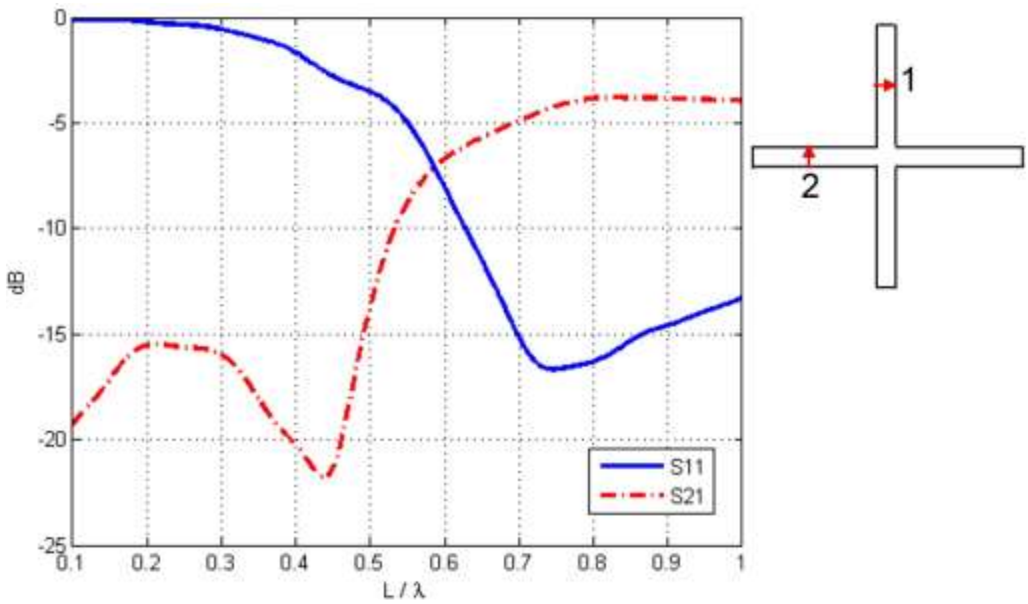

Figure 2.2.*S*-parametersforacrossedslotonafinitegroundplanewithtwoasymmetricports.S11and S22are identical.

At around *L*/□ = 0.7, the antenna has good match (*S*11 < -15 dB), but the mutualcoupling, measured using |*S*21| is high. This result indicates the existence of strongcouplingbetween thetwo asymmetricports.

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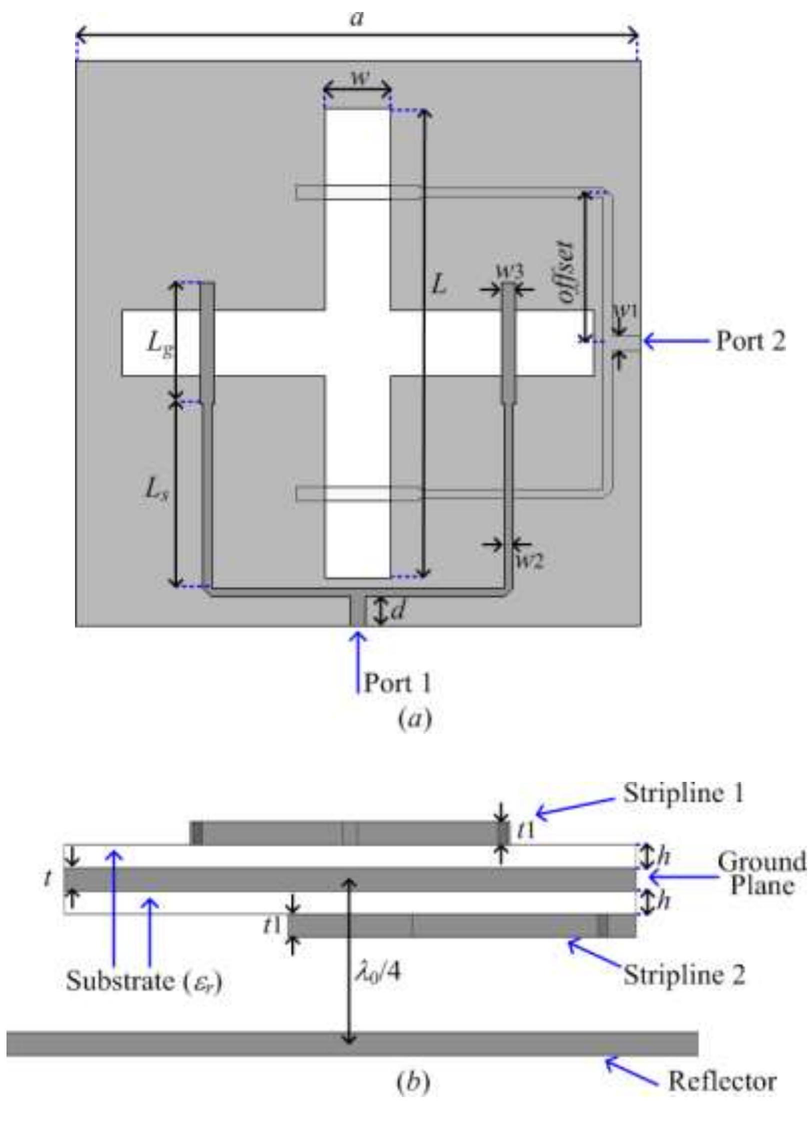

Figure 2.3. The geometry of crossed slot antenna with a pair of microstrip lines.(a = 50 mm, d = 10 mm, h = 0.5 mm, L = 32.5 mm, L_g = 6.5 mm, L_S = 24mm,$offset$=10.5mm,t=0.05mm,t_1=0.05mm,w=5.4mm,w_1=0.45mm,w_2=1.55mm,w_3=3mmand□r=2.2).(a)Top view.(b)Sideview.

The symmetrical structure is taken into account as the two unequal ports do not provide adequate insulation. Figure 2.3 illustrates the realization of microstrip lines. The cross aperture antenna consists of two microstrip lines on the upper and lower layers. These have a sandwich-like structure to prevent the forage from being on a single layer, which can lead to cross-coupling deterioration. Backward radiation is prevented by using a ground level below the surface of the hole. The quarter wavelength gap is ideal for operating the reflection mechanism. The size of the reflector is slightly larger than the size of the aperture surface. In this case the ground plane size is not optimized.

For satisfactory impedance matching, the model was troubled and simulated in CST. Figure shows the parameters of 2.4 S, −10 dB S11 bandwidth 34% and impedance-matched range between ports less than 5050 dB S21. It is possible to calculate the so-called shell correlation coefficient between two ports using [102], taking into account the missing antenna and several additional (although rarely pronounced) special criteria.

$$\rho_e \square \frac{\left|S_{11}^{*}S_{12}+S_{21}^{*}S_{22}\right|^2}{\left(1-\left|S_{11}\right|^2-\left|S_{21}\right|^2\right)\left(1-\left|S_{22}\right|^2-\left|S_{12}\right|^2\right)}$$

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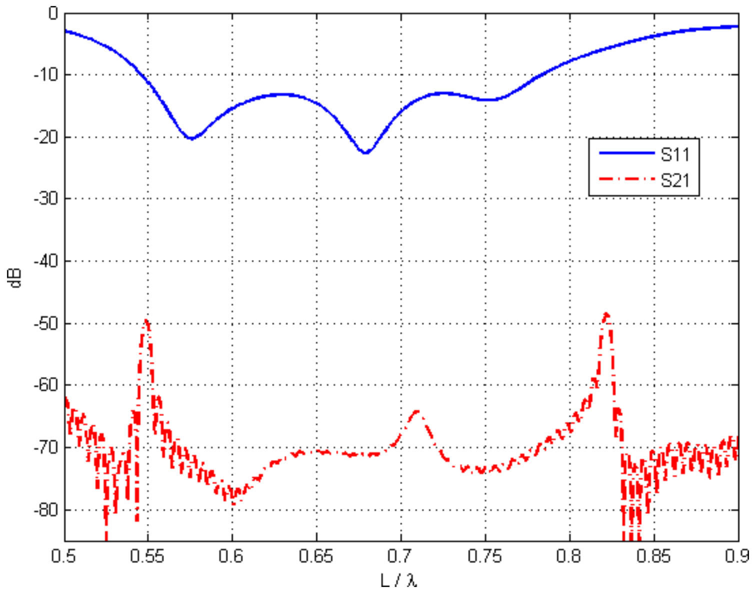

Figure 2.4. S-parameters of the simulated crossed slot antenna.

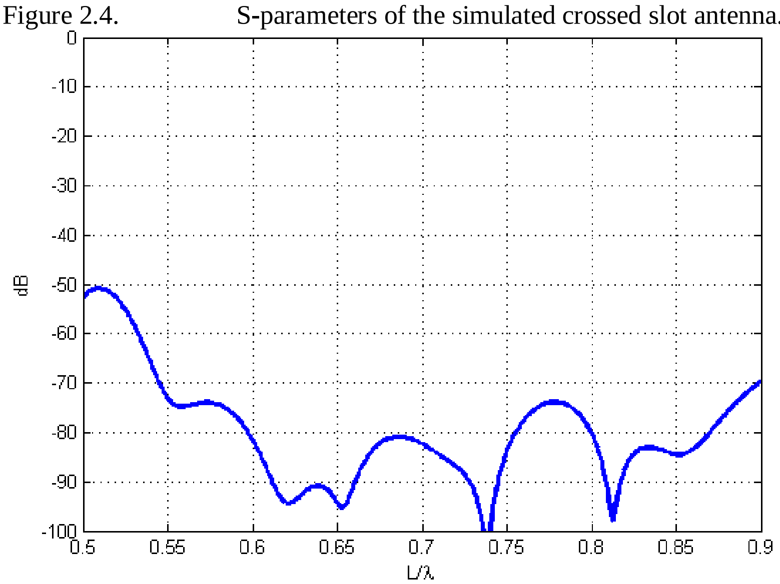

Figure 2.5. The envelope correlation coefficient of the crossed slot antenna.

Figure 2.5 shows the result, which shows a much higher level of isolation between the two ports. Figure 2.6 shows the diagrams between the boundary of the two bands and between the frequencies. At these three frequencies, the gain of the wide antenna is approximately 8-10 dB. Compared to any type of antenna, the polarity purity is prominent on the display side and is acceptable in other forward directions. These are the feed lines that cause specific inequality in the pattern.

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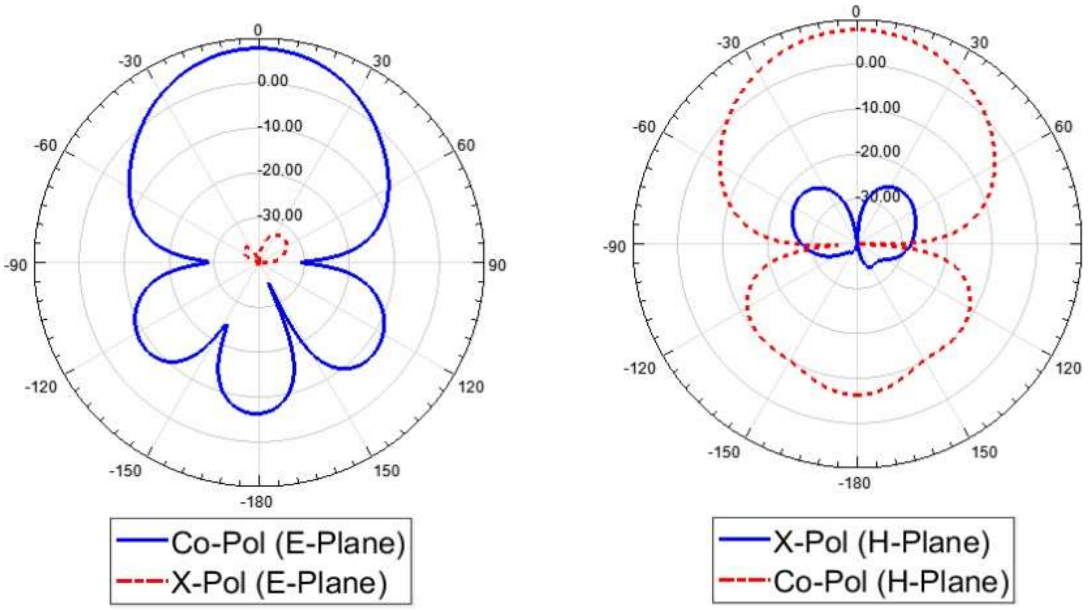
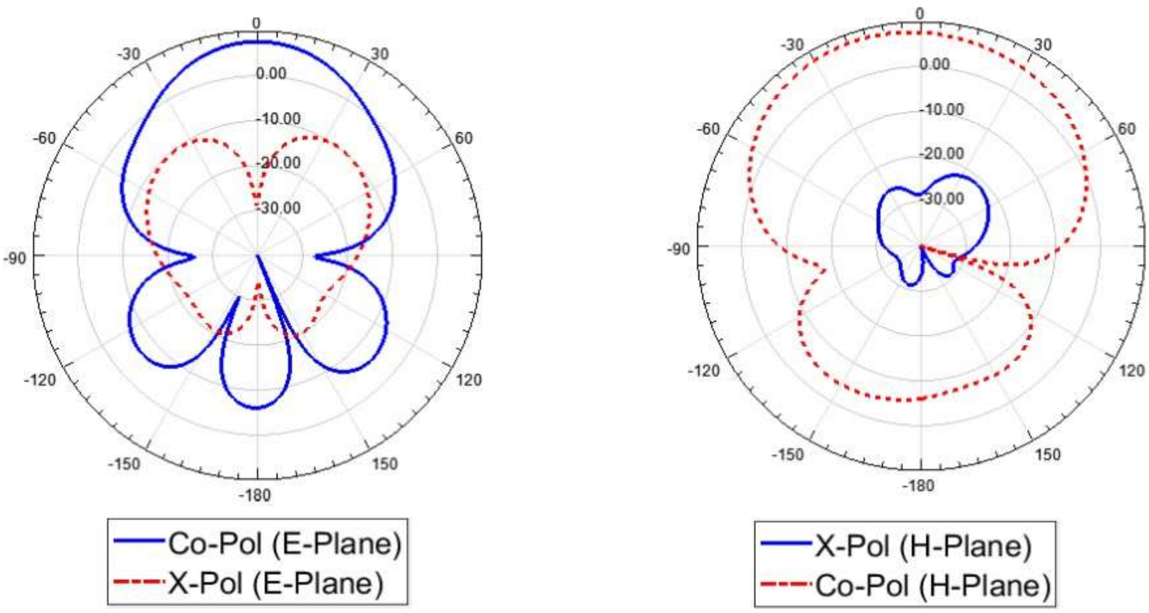
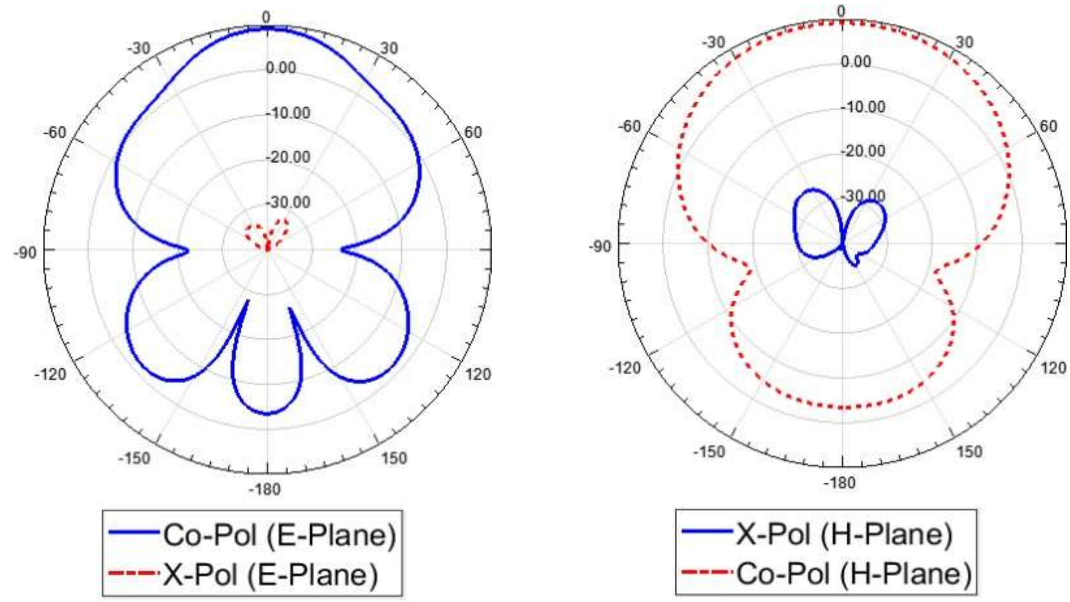


(a)



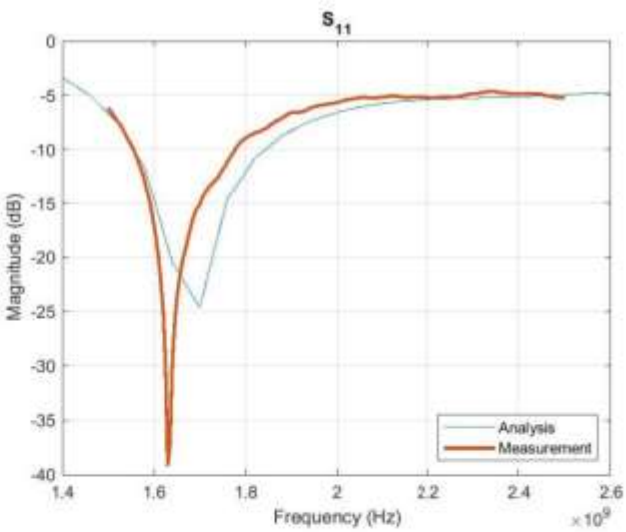
(b)



(c)

Figure 2.6. Simulated Far Field Radiation Patterns. (a) L / λ = 0.6. (B) L / λ = 0.65. (C) L / λ = 0.7.

The above design demonstrated that thecrossed slot can generate dual polarizations with high isolation. The following section further applies this concept in acavity-back slot design for synthetic apertureradaratthelow-frequencyband(L-band).



(a)

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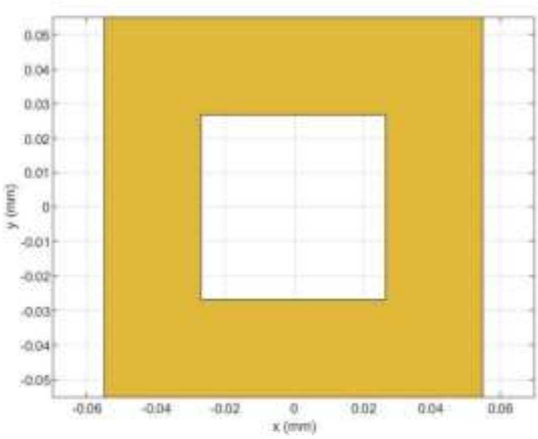

(b)

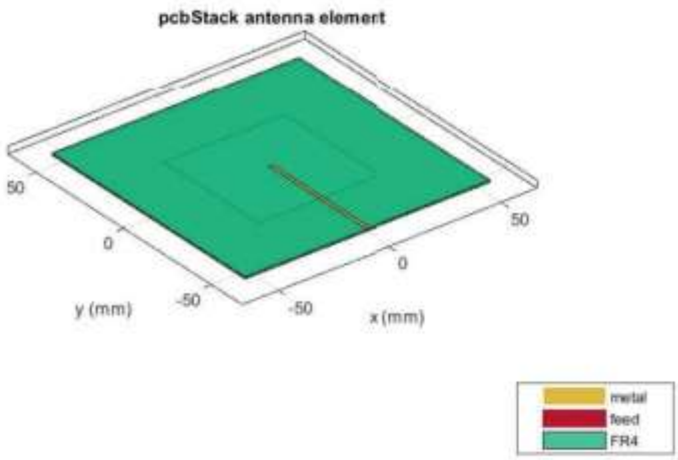

Figure2.7Phase centerestimate of the 6-elementresonant slot array across frequency.
(a)□*y*component(alongwaveguide'sheightdirection).

(a) □*z*component(alongwaveguide'slongitudinaldirection).
3.ConclusionsandFutureWorks

Theslotantenna,inventedin1938,iscontinuingtoberesearchedwithnewarticlesappearingintheliteratureregularly.Itsfullpotentialdoesnotseemtohavebeenrealizedsofar,withnewproperties,designs,andapplicationsappearingregularly.Itsadvantagesinclude high radiation efficiency, power handling ability, low profile, low loss, lightweight,and ease of fabrication. When used in an array, there are high radiation- and aperture-efficiencies. This dissertation contributes to the analysis and design of slot elements, andinparticular,slotarrays.

Single linear polarization is provided by a simple waveguide slot array and it is still difficult to propagate both poles using a single slot and supporting cavity structure. A new, simple-slit, dual-band, dual-polarity aperture series on a metal surface is proposed in Chapter 2. A cavity-supported cross-slit antenna with

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dual polarity forms the lower band portion. In the corrugated waveguide, there is a slot matrix for the high band component. In a simple slot configuration, these two sets of slot components can be arranged to fit neatly. As a result, the slot capacity is very high and the mechanical basis of the sandwich metal structure is excellent. The prototype is prepared and measured. The proposed configuration that combines single-polarized linear arrays and bipolar cross-slot components can be used in many ways for geospatial applications, although it is specifically intended for SAR space.

Most of the aperture waveguide ranges in use today are built around rectangular waveguides. The triangular waveguide with aperture matrix is the subject of Chapter 3. The results came from a simulation that appeared to be a difficult analytical task to analyze the self-pattern of the isocellular triangular waveguide. The vertex angle of the isosceles triangle waveguide affects the dominant position.Theinternalfielddistributionofeachmodehelpstochoosemanufacturingtechniquesandfeedingforthetriangularwaveguide.Theslotconfigurationis studied based on the internal surface current distribution of triangular waveguide. Slotsare cut longitudinally on both sidewalls in a +/ configuration. The slot conductance isstudiedanalyticallyandnumerically.Aprototypeof5-elementslotarrayisbuilt,andphysicalmeasurementsconfirmthattheperformanceisnotsensitivetoagapatthevertexofthetriangularwaveguide.Thislow-lossmodeisfurtherdeployedinthesystem-on-chipapplication, which is fabricated by a self-assembly technique. Because of the roundedcornersofthetriangularshaperesultingfromtheself-assemblingmicrofabricationtechnique, the characteristics of the quasi-triangular waveguide are slightly different fromthe perfectly triangular waveguide. A 4-element on-chip triangular waveguide slot arraywasfabricatedtodemonstratethephysicalconstructionfeasibilityofthisantennaconcept.Fromsimulations,acircularconfigurationoftriangularwaveguidearrayantennasisshownto be able to generate several beams pointing at different azimuthal directions. Excitingeach of these arrays at the same amplitude and phase produces an azimuthally near-omnidirectional, high-gain pattern. Another application of the design concept is a half-polygonal waveguide placed on a metal ground plane. The potential application is forMIMOorradarantennaona wallorceiling,forbroadwireless coverage.

several applications - or design-related features of the slot matrix that do not overlap with the other two chapters. The first is the symmetry of the slit waveguide matrix resonating at very close frequencies and the distinctive feature of the beam patterns is that it does not appear to be documented in the open literature. The procedure for determining the 3D phase center of a hole array is proposed in the second section. By influencing the origin of the AUT, the new phase model is calculated from the initial phase model. The phase center is produced by minimizing the variance of the new phase pattern. On a typical computer, the calculation only takes minutes and ensures the correct answer to the test size despite the use of a comprehensive primitive search strategy. The last section provides a basic analysis and design of the transmission line for a microwave heating aperture device. The model allows rapid analyzes of changes in the permeability of the food as well as structural changes in the heating cavity, including the addition of additional layers.

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