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Compact microstrip patch antennas for Broad band applications

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Abstract

The development of a compact microstrip antennas configuration is presented. The system uses a number of parasitic elements which are probe fed slotted, chip resistor and stacked shorted patch for compact broad band microstrip antenna. The enhancement of bandwidth does not cause determination of the radiation of the system.

Key words: broad band, microstrip antenna

Introduction

Microstrip patch antennas (MPA) are a class of planar antennas which have been researched and developed extensively in the last four decades. They have become favourites among antenna designers and have been used in many applications in wireless communication systems, both in the military sector and in the commercial sector. The aim of this book is to provide a coherent account of the theory, analysis, and design of these antennas, as well as some recent developments. Since the authors have been involved with the research and development of MPAs from the early 1980's, this book can also be regarded as a partial record of their personal journeys in this field [1-3]. A significant fraction of the material is drawn from their own work in the last three decades

Table 1.1. Typical gain and bandwidth of conventional antenna elements.

Element	Typical gain	Typical bandwidth VSWR < 2)
Half-wave dipole/Folded dipole	2 dB	8–16%
Quarter-wave monopole	5 dB	8–16%
One wavelength loop	4 dB	10%
Yagi (Dipole + parasitic)	12 dB	5%
Dipole + Corner reflector	12 dB	8–16%
Helical antenna	16 dB	70%
Horn antenna	20 dB	20%

Microstrip Patch antennas are popular for their well known attractive features, such as a low profile, light weight and compatibility with monolithic microwave integrated circuits. Patch antennas are widely use because of their advantages. Patch antennas have some disadvantages, like narrow bandwidth. These advantages make microstrip patch antennas much more suitable for aircrafts, spacecrafts, and missiles than conventional antennas as they do not interfere with the aerodynamics of these moving vehicles.

In practice, it is rare that the performance specifications can be met by the basic microstrip patch antenna structure. Thick substrates and additional features, such as parasitic patches, shorting pins, or slots in the patch, have to be added. Unfortunately, once the structure departs from the basic geometry, it is not amendable to analysis via a simple model. Maxwell's equations must be solved and boundary conditions satisfied, a procedure known as full-wave analysis. Such analysis, while not providing much physical insight, does yield numerical results predicting the performance of the antenna structure[4-7].

Antenna geometry

With a size reduction at a fixed operating frequency, the impedance bandwidth of a microstrip is usually is decreased. To get the enhanced impedance bandwidth, one can simply increase the antenna thickness substrate to compensate for the decreased electrical thickness of the substrate due to the lowered operating frequency or one use a ground plane or a slotted ground plane. These design methods lower the quality of factor of compact microstrip antenna and resulting that enhanced impedance bandwidth.

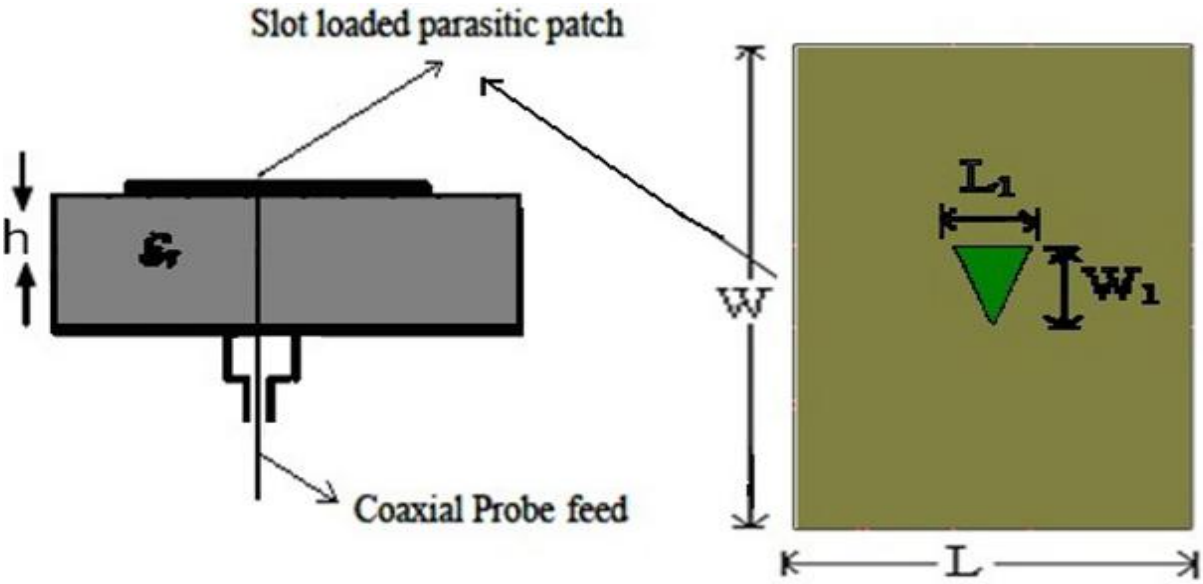

Fig 1. Geometry of a probe fed slotted triangular microstrip antenna for compact broadband operation.

By embedding suitable slots in a radiating patch, compact operation with an enhanced impedance bandwidth can be obtained. A typical design is shown in figure. However, the obtained impedance bandwidth for such a design is usually about to or less than two times that of the corresponding conventional microstrip antennas. To achieve a much greater impedance bandwidth with a reduction in antenna size. One can use compact designs with chip resistor loading or stacked shorted **patches.**

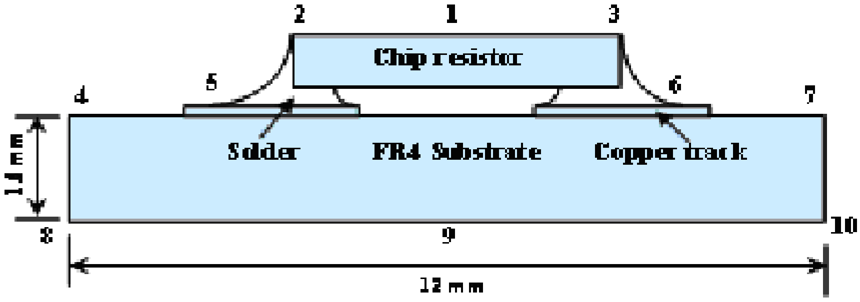

Fig 2. Geometry of a compact broadband microstrip antennas with chip resistor loading

The previous design is achieved by replacing shorting pin in a shorted patch antenna with a chip resistor of low resistance (generally 1 ohm). In this case, with the same antenna parameters, the obtained size reduction can be greater than for the design using chip resistor loading. Moreover, the obtained impedance bandwidth can be increased by a factor of six compared to a design using shorting pin loading. For an FR4 substrate of thickness 1.6mm and relatively permittivity 4.4, the impedance bandwidth can reach 10% in L band operation. However, due to the introduced ohmic loss of the chip resistor loading, the antenna gain is decreased and is still about 2dB compared to shorted patch antenna with a shorting pin. Then the stacked shorted patches, an impedance bandwidth of greater than 10% can be obtained. For this the total antenna height or volume is increased.

Compact microstrip antennas with dual frequency operation have attracted [8-10]. The two operating frequencies can have the same polarization planes or orthogonal polarization planes. The obtained frequency ratios between the two operating frequencies have been reported to be about 2 to 3.2, 2.55 to 3.83 and 2.5 to 4.9 for shorted rectangular, circular and triangular patches respectively.

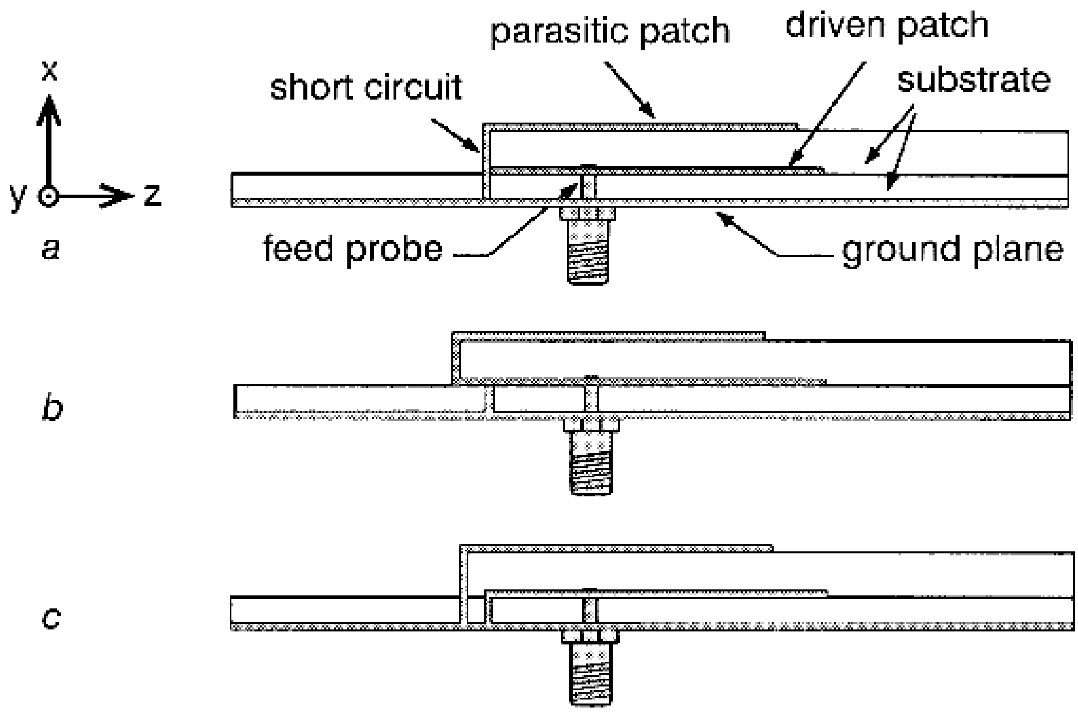

Fig3. Geometry of a stacked shorted patch for compact broadband operation

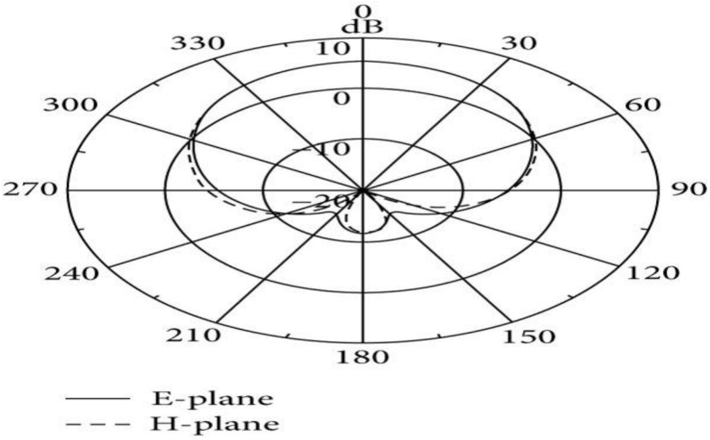

Fig.4 Radiation pattern of broadband microstrip patch antenna

Conclusion

Different types of microstrip patch antennas like probe fed, chip resistor method and stacked shorted patch has been presented. The antenna has a low profile and high impedance bandwidth. The radiation pattern is well suitable for broadband applications it is anticipated that this design will find application in hand held communication systems where light wight and compactness are the most desirable criteria. in addition to the lowered resonant frequency, which leads to a possible antenna size reduction, the antenna studied also has widened impedance bandwidth and enhanced antenna gain, which are advantages over compact designs w. In addition to the lowered resonant frequency, which leads to a possible antenna size reduction, the antenna studied also has widened impedance bandwidth, which are advantages over compact designs with a slotted radiating patch

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