EFFECTS OF SLOTS ON MICROSTRIP PATCH ANTENNA

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ABSTRACT: *Antenna ia backbone of communication system with the advent of technology a lot of innovation happens to develop the antenna. Antenna is a smart device which not only transmit and receive but also work as a transducers. This paper presents effect of slots on microstrip patch antenna and its parameters. The effect is shown on bandwidth, gain, radiation pattern, return loss, axial ratio and size of an antenna. The slots on the patch or on the ground plane will help to design a antenna with improved bandwidth and effeciency.*

Key words: *microstrip patch antenna, slots, bandwidth, gain, efficiency.*

1.INTRODUCTION

Microstrip slot antennas invented in 1938 by Alan Blumlein. Slot radiator or slot antennas are antenna that are used in frequency range from about 300 mhz to 25 ghz. They are often used in navigation radar usually as an array fed by a waveguide. With ever increasing demand for reliable wireless communication, the need for efficient use of electromagnetic spectrum is on the rise. But also older large phased array antenna used the principle because the slot radiators are very inexpensive way for frequency scaning array.

The slot behaves according to Babinet's principle as resonant radiator. Jacques Babinet (1794-1872) was a French physicist and mathematician, formulated the theorem that similar diffraction patterns are produced by two complementary screens .This principle relates the radiated field and impedance of an aperture or slot antenna so that of the field of a dipole antenna.It can also provide the low profile, low cost, small size, easier integration with other circuits and conformability to a shaped surface. Nowsday numerous slot antenna design for 2.4/5 ghz dual band WLAN operations have been reported. Slots antenna are an about $\lambda/2$ elongated slot, cut in a conductive plate and exicted in the center.

Microstrip slot antenna is simple in structure. It consist of microstrip feed that couples electromagnetic waves through the slot above and slot radiates them. A microstrip fed antenna offers a better isolations between the feed and the material under measurement campared to the microstrip fed microstrip antenna. They are more flexible in integration with other active and passive device in a hybrid MIC and MMIC design. Furthermore they are capable of producing omnidirectional radiation patterns by simply inserting quarter wave thick foam and reflector. We find the great use of slot antennas for fixed stations satellite ground stations and becon with proper mounting a slot antenna can also be used in microwave mobile.

2.EFFECT OF SLOT ON DIFFERENT PARAMETERS OF MICROSTRIP PATCH ANTENNA

2.1. EFFECT OF SLOTS ON BANDWIDTH

Bandwidth is also defined in terms of radiation parameters. It is defined as frequency range over which radiations parameters such as gain, HPBW, side lobes levels are within specified minimum and maximum limits.

In terms of voltage standing wave ratio or input impedance variation with frequency or in terms of radiation pattern.The VSWR or impedance bandwidth of microstrip patch antenna is defined as the frequency range over which it is matched with that of fed line with in specified limits. The bandwidth of microstrip patch antenna is defined as the frequency range over which it is matched with that of feed line within specified limits. The bandwidth of microstrip patch antenna is inversely proportional to it quality factor Q is given by

Bandwidth=$\frac{VSWR-1}{Q\sqrt{VSWR}}$

The bandwidth is usually specified as frequency range over which VSWR is less than two .Some times for stringent application the VSWR requirement .The bandwidth of the antenna increases with the help of slots .These structures are periodic in nature that forbids the propogation of all electromagnetic surface waves within a particular frequency band called bandgap thus permitting additional control of the behavior of electromagnetic waves other than conventional guiding /filtering structure.

2.2. EFFECT ON SLOTS ON THE GAIN

Gain relates the intensity of antenna in a given direction to the intensity that would be produced by a hypothetical ideal antenna that radiates equally in all direction or isotropically and has no losses. By using high permittviity substrate and by different shape of slot we can enhance the gain of antenna.

2.3. EFFECT OF SLOT ON RADIATION PATTERN

Radiated electric field pattern of slot can be obtained from $\overrightarrow{E=}\ \overrightarrow{-\nabla} * \overrightarrow{F}$ where F is electric vector potential at any point in space. In spherical coordinate system the electric field is given by

$$\overrightarrow{E=}\ \frac{\mu_r}{r\sin\theta}\left[\frac{\partial}{\partial\theta}\ (F_\theta\ \sin\theta)-\frac{\partial F_\theta}{\partial\phi}\right]-\frac{\mu_\theta}{r}\left[\frac{1}{\sin\theta}\frac{\partial F_r}{\partial\theta}-\frac{\partial}{\partial r}\ (rF_\theta)\right]+\frac{\mu_\phi}{r}\left[\frac{\partial}{\partial r}(rF_\theta)-\frac{\partial F_r}{\partial\theta}\right]$$

From this we can easily calculate ϵ_r ,ϵ_θ,ϵ_ϕ terms.

Radiation patterns of slots are computed by using E fields slot behave as magnetic dipole when the slots are at ground plane. The E plane radiation pattern changes significantly for the finite size ground plane. This is due to diffraction effects from the edges of the finite size ground planes.

The E plane radiation pattern extented ground plane shows that the slots tends to become magnetic dipole. Due to lack of some experimental facilities the measured results are not provided. The radiation pattern by slot show the diffraction effects from the edges of finite size ground plane only affects the E plane radiation patterns of slots.

2.4. EFFECT OF SLOTS ON RETURN LOSS

Return loss is the difference between forward and reflected power in dB generelly measured at the input to the coaxial cable connected to the antenna. If the power transmitted by the source is P_T and the power refelcted back is P_R then return loss is given by P_R divided by P_T. For maximum power transfer the return loss should be as small as possible. This means ratio P_R/P_T should be small as possible. For example a return loss of -40 dB is better than one of -20 dB.

RL=-20log|Γ|(db)

|Γ| is reflection coefficient and it is given as $|\Gamma| = \frac{P_R}{P_T} = \frac{(Z_L - Z_o)}{(Z_L + Z_o)}$

Where,

P_R= Radiated power

P_T= Transmitted power

Z_L=Load impedance

z_o= Characteristic impedance

Selection of feeding technique for a microstrip patch antenna is important decision because its affects the bandwidth ,return loss ,VSWR patch size and smith chart. Using double or dual slot stacked patch technique use can get better return loss by increases the length and width of slot antenna return loss can be reduced.

2.5. EFFECT OF SLOT ON AXIAL RATIO

It is defined as ratio between minor and major axis of polarization ellipse. Shorter slot length produces narrower axial ratio bandwidth.

2.6. EFFECT OF SLOT ON SIZE OF ANTENNA

With the help of slot size of microstrip patch antenna is reduced. This effect can be done by changing the path of current. When slots are cut into patch current is changed. Current travels extra patch as campare to the without slot microstrip patch antenna.

3. CONCLUSION

By using different shape of slots we can improve efficiency of antenna as campare to conventional microstrip patch antenna. In this paper we have seen the effect of slot on microstrip patch antenna. By the use of slot we can enhance bandwidth, gain e.t.c.. Return loss is reduce. Axial ratio and radiation pattern is also improved. By the use of slot microstrip antenna can be used in many application.

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