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Design and Characterisation of Spherical Optical Nano Antenna

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Abstract

In this present research paper "DESIGN AND CHARACTERISATION OF SPHERIAL OPTICAL NANO ANTENNA" specific design of nano antenna and its performance is studied. The spherical optical nano antenna has been designed by a single gold nano sphere of diameter 215nm which generates electronic surface wave known as Surface Plasmon. It is due to confining of electromagnetic wave between the geometry of gold nano sphere and a rectangular dielectric space.

Index terms – Nano antenna, Surface Plasmon.

INTRODUCTION

The fast development of modern society has excellent progress in invention and innovation of nano phase materials used in electromagnetic field. The nano scale materials have potential properties and application in various disciplines such as physics, chemistry and biology related to the electromagnetic wave, especially in visible range. The working principal of nano antenna is associated with plasmonic resonance. The behavior of optical nano antenna is analysed with the help of polarization pattern, radiation pattern, smith chart of field .This study is an effort to improve and develop the understanding of nano antenna and its application. The present research focuses on a kind of nano structure 'single nano sphere' which serves as optical nano antenna. The interest of research is to analyse the performance of optical spherical nano antenna with their characteristic parameters.

DESIGN OF SPHERECAL OPTICAL NANO ANTENNA

The optical nano antenna designed by a gold sphere of nano - scale of diameter (215nm) is place at the co-ordinate (0, 0, 1) which is mentioned in fig no-1. This gold nano scale sphere enclosed by a rectangular space of dimension $(1\times1\times2)m^3$, the face center of this rectangular space placed at co-ordinate (0, 0, 0) with isotropic medium of air. The separation is 1 nm between gold nano sphere and rectangular isotropic air medium by a rectangular vacuumed space from the center gold nano sphere which is depicted in the figure. In rectangular space the plane Y-Z is perfect electric field, the X-Z plane is perfect magnetic field and the radiation plane is defined by X-Y plane. An ordinary limp port is arranged along Y- axis which excites the spherical nano antenna with electromagnetic wave of wave length 4500 A^0 and frequency 667 THz as given in fig no-2.

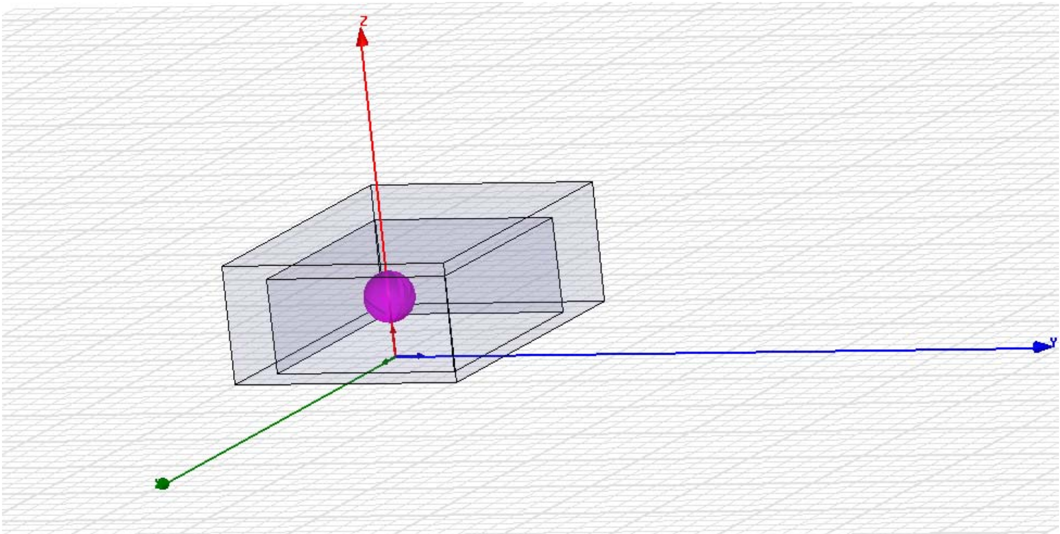

Fig no -1

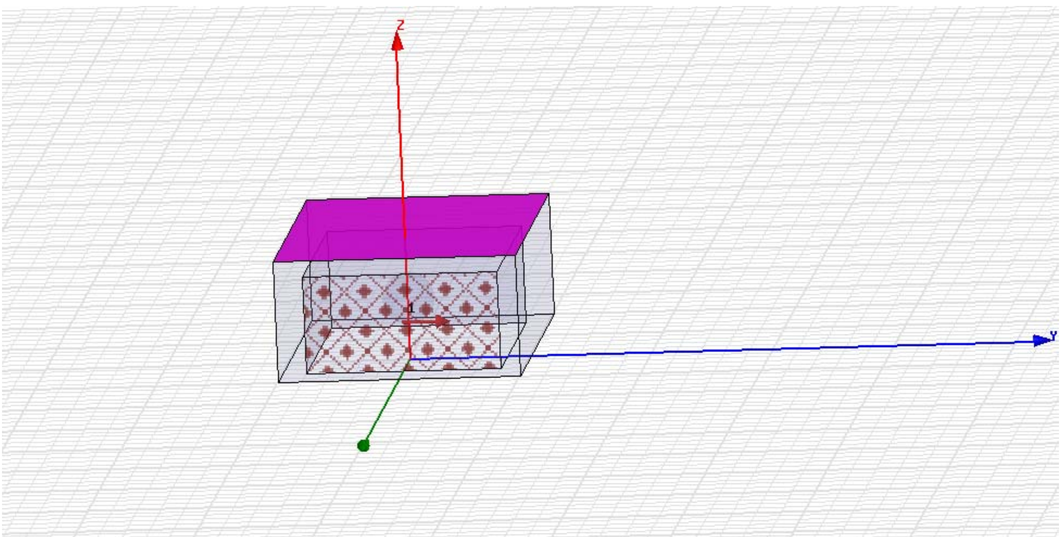

Fig no-2

CHARATERISATON OF SPHERICAL OPTICAL NANO ANTENNA

The radiation field from transmitting or receiving antenna is characterised by pointing vector P = E×H, where E is an electric field and H is a magnetic field. The space close to the antenna, the pointing vector is imaginary (reactive) and further away its real (radiative). Therefore the space around antenna is classified into three regions: (1) Reactive region (wave length/2π), (2) Near field (2×square dimension of antenna/wave length) and (3) Far field (the distance more than near field).

POLARISATION OF OPTICAL SPHERICAL NANO ANTENNA

The polarization pattern of optical spherical nano antenna is measured in rectangular and spherical polar format. The result of RHCP, LHCP and radiation pattern is measured in two dimensions for far field and near field.

MEASUREMENT OF RHCP AND LHCP POLARISATION PATTERN FOR NEAR FIELD

The measurement of polarization pattern of RHCP and LHCP of spherical nano antenna for near field is exhibited in fig no-3 & 4 . The amplitude of field pattern is measured normalized electric field intensity with only one of the direction angle θ varies.

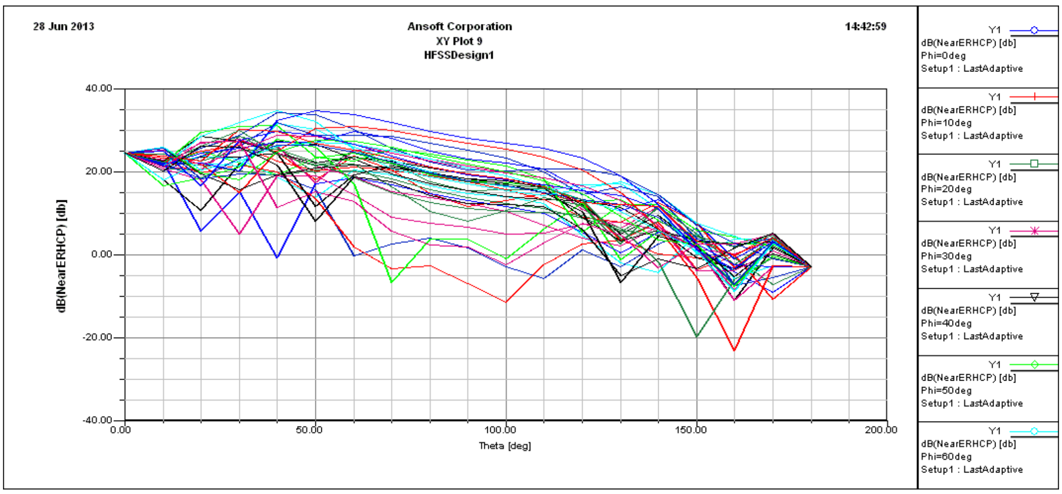

fig no-3

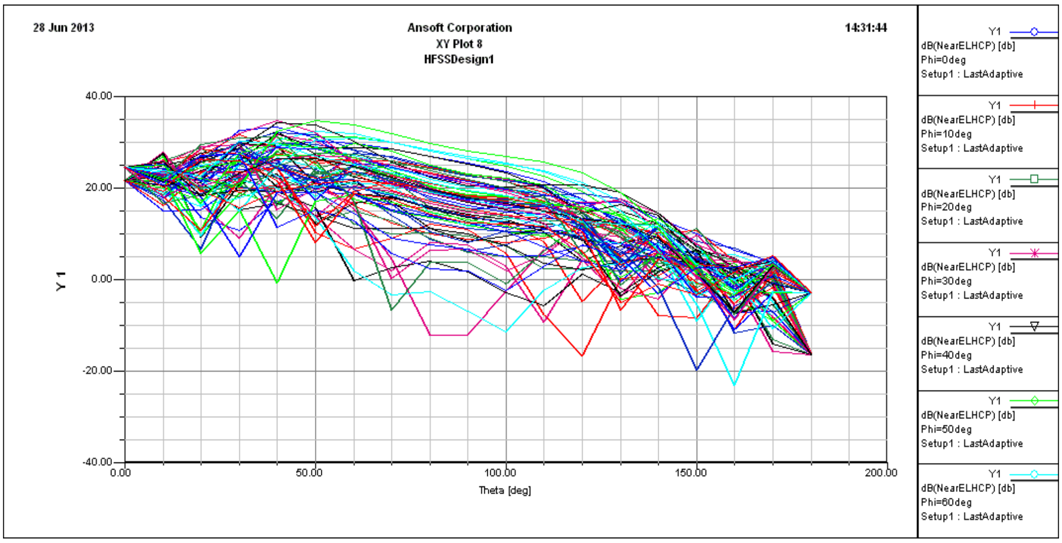

fig no-4

MEASUREMENT OF RHCP AND LHCP POLARISATION PATTERN FOR FAR FIELD

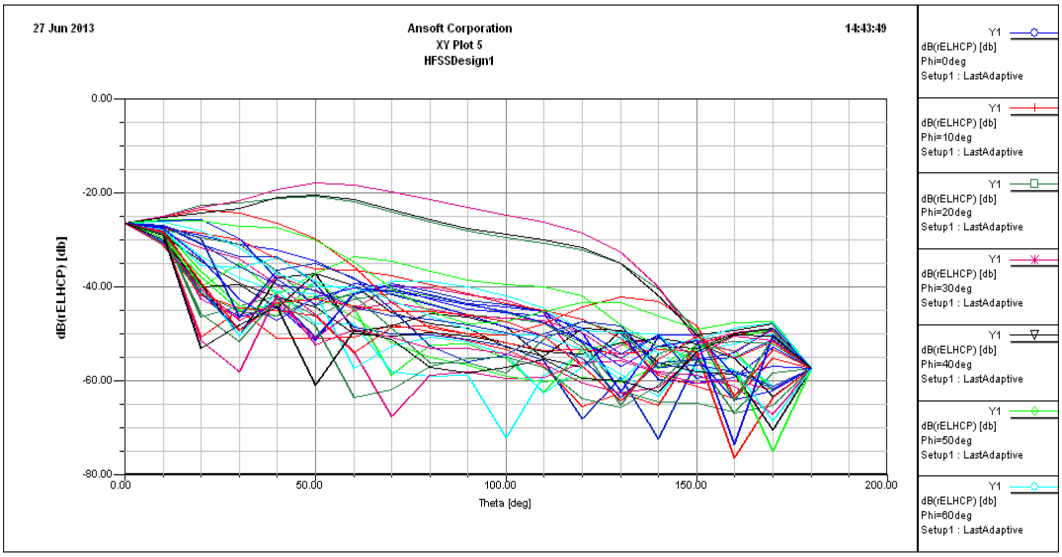

fig no-5

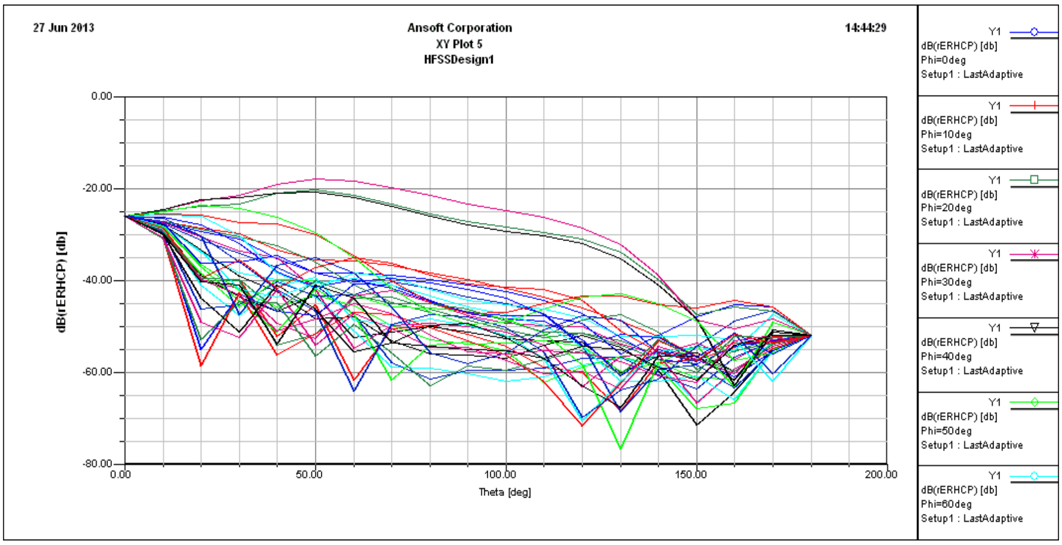

fig no-6

MEASUREMENT OF RADIATION PATTERN FOR NEAR FIELD

The radiation pattern of spherical nano antenna is a measurement of the distribution of the power or energy radiated from antenna or received to the antenna as a function of direction angles from the antenna. The measurement of radiation pattern of RHCP and LHCP of spherical nano antenna in polar form for near field and far field are showing in fig no-7 & 8 and fig no-9&10 respectively.

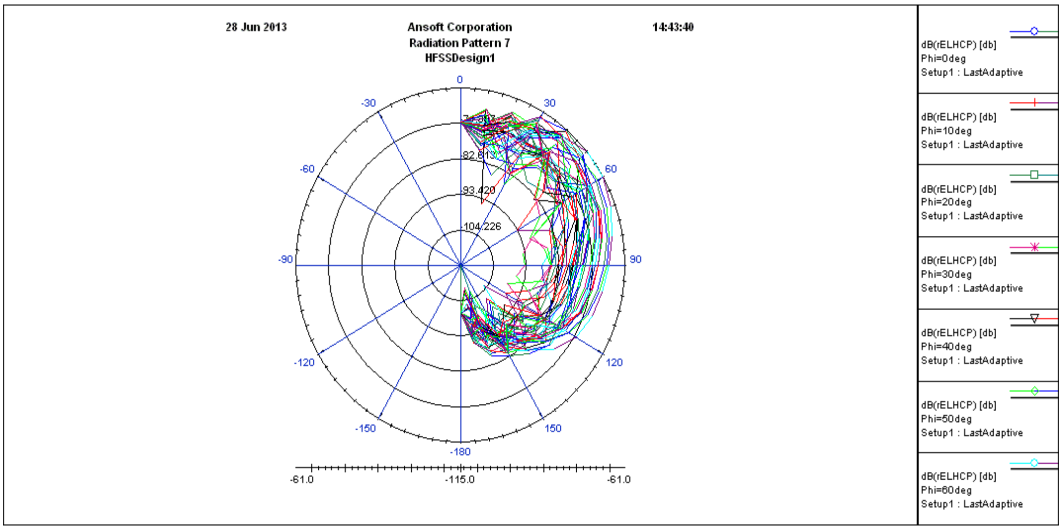

fig no-7

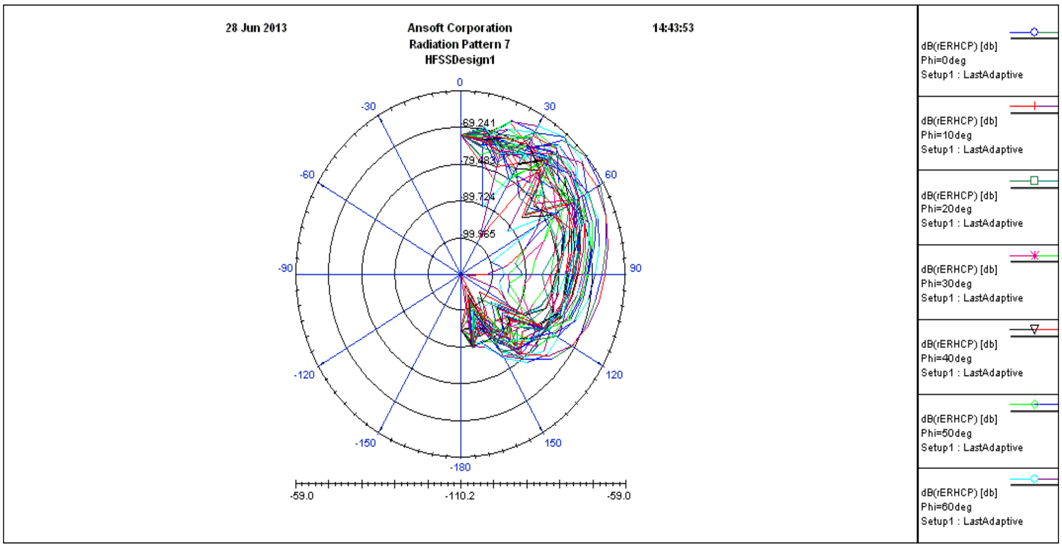

fig no-8

MEASUREMENT OF RADIATION PATTERN OF RHCP AND LHCP FOR FAR FIELD.

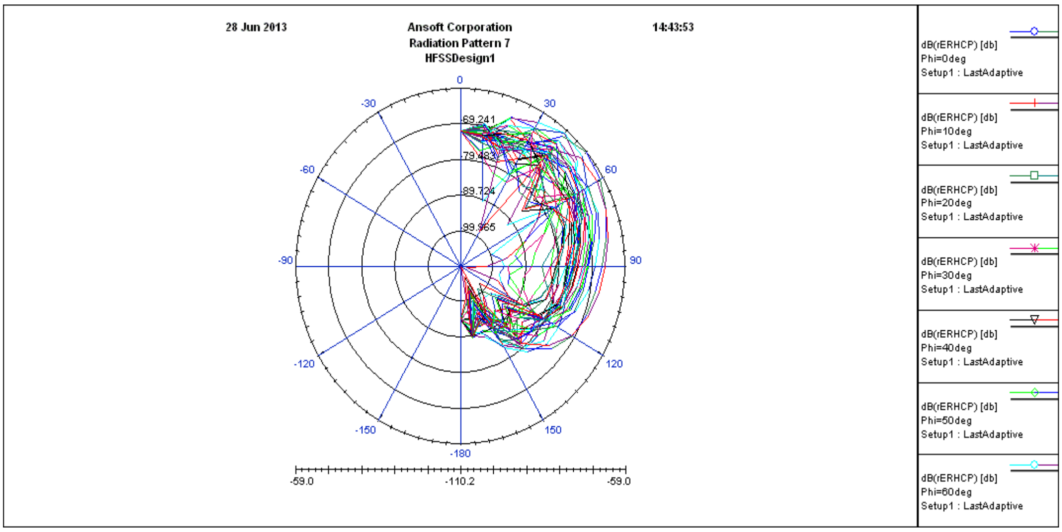

fig no-9

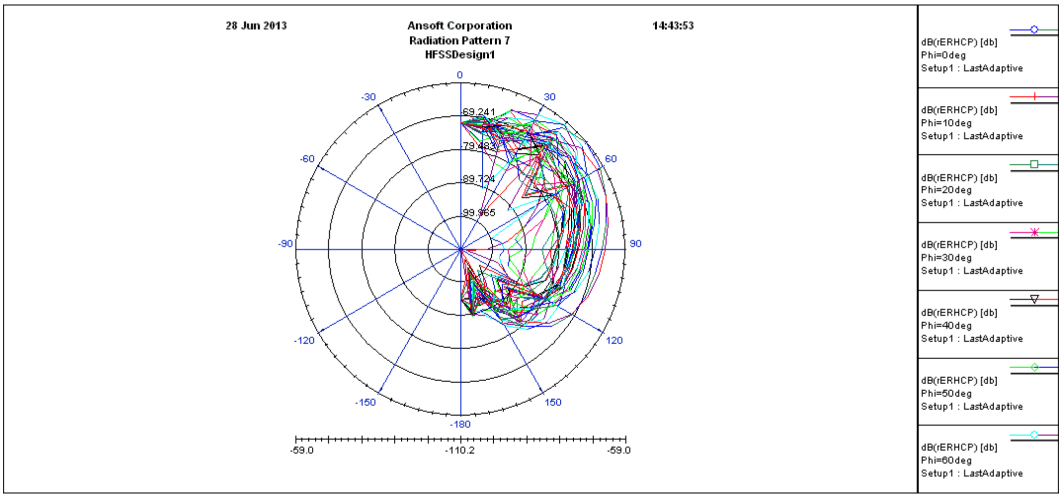

fig no-10

SMITH CHART OF SPHERICAL OPTICAL NANO ANTENNA

The smith chart of spherical optical nano antenna is in fig no-11 at frequency 445 THz. The value of Rx = -1.59-j 1.69, GB = -0.204+j 0.313, VSWR= 3.758. The VSWR of the observed radiation pattern calculated from smith chart comes to be 3.758, which we approximate as VSWR = 4. This gives reflected power percentage as 30.9% making the total loss of transmitted signal as -5.10 db, which concludes total normalised transmitted power as 95% approximately.

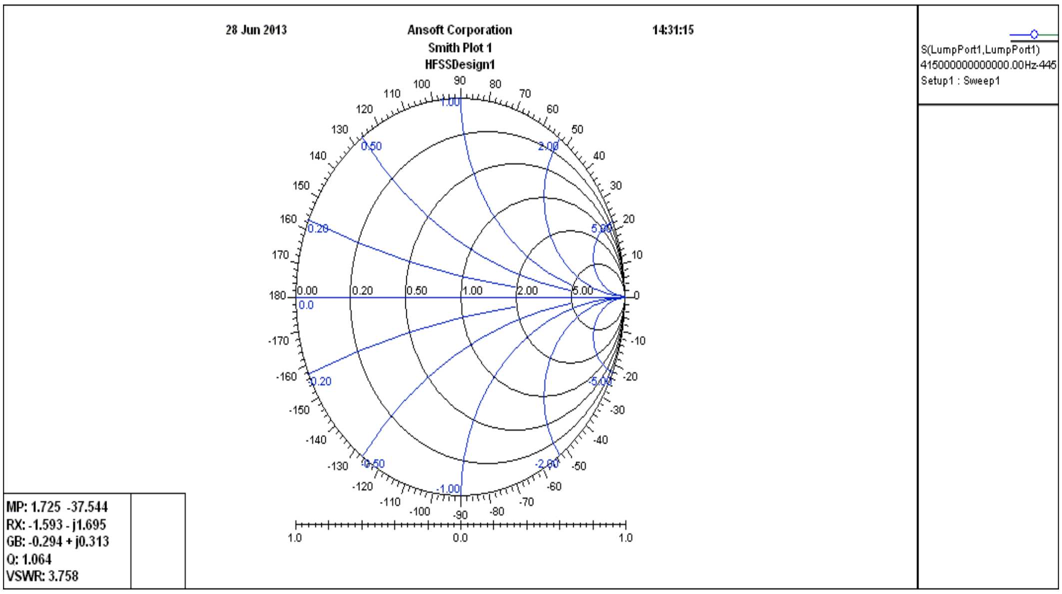

Fig no-11

CONCLUSION

The research examined the performance of the designed spherical nano antenna with the aspect of polarisation, radiation pattern and smith chart. The polarisation pattern shows uniform distribution in azimuth plane over elevation plane that provides more capability of rotation of antenna in various directions. The resulting power or energy of radiation pattern is uniformly distributed at every angle with VSWR = 4(approx) demonstrating reflected power percentage being 30.9% making the total loss of transmitted signal being -5.10 db, which concludes that total normalised transmitted power is approx 95%.

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