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DESIGN AND ANALYSIS OF DISCONE ANTENNA

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ABSTRACT:A discone antenna is a version of a biconical antenna in which one of the cones is replaced by a disc. It is usually mounted vertically, with the disc at the top and the cone beneath. A discone antenna is a version of a biconical antenna in which one of the cones is replaced by a disc. It is usually mounted vertically, with the disc at the top and the cone beneath. Omnidirectional, vertically polarized and exhibiting unity gain, it is exceptionally wideband, offering a frequency range ratio of up to 10:1.The radiation pattern in the vertical plane is quite narrow, making its sensitivity highest in the plane parallel to the Earth. The discone's wideband coverage makes it attractive in commercial, military, amateur radio and radio scanner applications. The radiation fields of the discone antenna with an oblique cone can be derived from the fields of an equivalent Huygens source on the aperture. For a symmetrical discone antenna, the numerical and experimental radiation patterns are presented. For an asymmetrical discone antenna with an oblique cone, the radiation patterns are also presented. The curves of the front-to-back ratio on the patterns of the horizontal plane are shown for various oblique cone shapes.

Keywords: Discone Antenna, Omnidirectional, Sensitivity.

I.INTRODUCTION:

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency (i.e. high frequency AC) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified. Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected (often through a transmission line) to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time- varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna. Antennas may also include reflective or directive elements or surfaces not connected to the transmitter or receiver, such as parasitic elements, parabolic reflectors or horns, which serve to direct the radio waves into a beam or other desired radiation pattern. Antennas can be designed to transmit or receive radio waves in all directions equally.

Antennas are required by any radio receiver or transmitter to couple its electrical connection to the electromagnetic field. Radio waves are electromagnetic waves which carry signals through the air (or through space) at the speed of light with almost no transmission loss. Radio transmitters and receivers are used to convey signals (information) in systems including broadcast (audio) radio, television, mobile telephones, wi-fi (WLAN) data networks, trunk lines and point-to-point communications links (telephone, data networks), satellite links, many remote devices such as garage door openers, and wireless remote sensors, among many others. Radio waves are also used directly for measurements in technologies including RADAR, GPS, and radio astronomy. In each and every case, the transmitters and receivers involved require antennas, although these are sometimes hidden (such as the antenna inside an AM radio or inside a laptop computer equipped with wi-fi).

According to their applications and technology available, antennas generally fall in one of two categories:

1) Omnidirectional or only weakly directional antennas which receive or radiate more or less in all directions. These are employed when the relative position of the other station is unknown or arbitrary. They are also used at lower frequencies where a directional antenna would be too large, or simply to cut costs in applications where a directional antenna isn't required.

2) Directional or beam antennas which are intended to preferentially radiate or receive in a particular direction or directional pattern.

II.DISCONE ANTENNA

A discone antenna is a version of a biconical antenna in which one of the cones is replaced by a disc. It is usually mounted vertically, with the disc at the top and the cone beneath. Omni directional, vertically polarized and exhibiting unity gain, it is exceptionally wideband, offering a frequency range ratio of up to ~10:1. The radiation pattern in the vertical plane is quite narrow, making its sensitivity highest in the plane parallel to coverage makes it attractive in commercial, military, amateur radio and radio scanner applications.

When employed as a transmitting antenna, it is often less efficient than an antenna designed for a more limited frequency range. SWR (standing wave ratio) is typically ~2:1 over the range of the design frequency to the second harmonic and ~3.1 thereafter. A discone antenna typically has at least three major components: the the cone, and the insulator. The disc should have an overall diameter of 0.7 times a quarter wavelength of the antenna's minimum frequency. The antenna's feed point is at the center of the disc. It is usually fed with 50 Ω coaxial cable, with the center conductor connected to the disc, and the outer conductor to the cone. The length of the cone should be a quarter wavelength of the antenna's minimum operating frequency. The cone angle is generally from 25 to 40 degrees. The disc and cone must be separated by an insulator. In order to extend low-frequency response, a vertical whip may be placed affixed vertically to the disc. But this may reduce efficiency at higher frequencies. In this configuration, at lower frequencies the discone may more closely resemble a ground plane antenna or a coaxial dipole.

Description:

The discone antenna has a useful frequency range of at least 10 to 1. When employed as a transmitting antenna, it is often less efficient than an antenna designed for a more limited frequency range. A discone antenna consists of three main parts: the disc, the cone, and the insulator.

1. **The Disc**: The disc should have an overall diameter of 0.7 times a quarter wavelength of the antenna's lowest frequency. The antenna's feed point is at the center of the disc. It is usually fed with coaxial cable, with the center conductor connected to the disc, and the outer conductor to the cone.
2. **The cone**: The length of the cone should be a quarter wavelength of the antenna's lowest operating frequency. The cone angle is generally from 25 to 40 degrees.
3. **The insulator**: The disc and cone must be separated by an insulator, the dimensions of which determine some of the antenna's properties, especially on near its high frequency limit.

III.CONSTRUCTION AND ANALYSIS

A discone may be made from solid metal sheet (often copper), which is practical for small indoor UHF antennas, such as for Wi-Fi. At lower frequencies a sufficient number of metal wires or rods in a spoke configuration is often used to approximate a solid surface. This simplifies construction and reduces wind loading. The spokes may be made of stiff wire, brazing rods or even coat hanger wire. The optimal number of rods comprising the disc and cone is often quoted as being from 8 to 16.

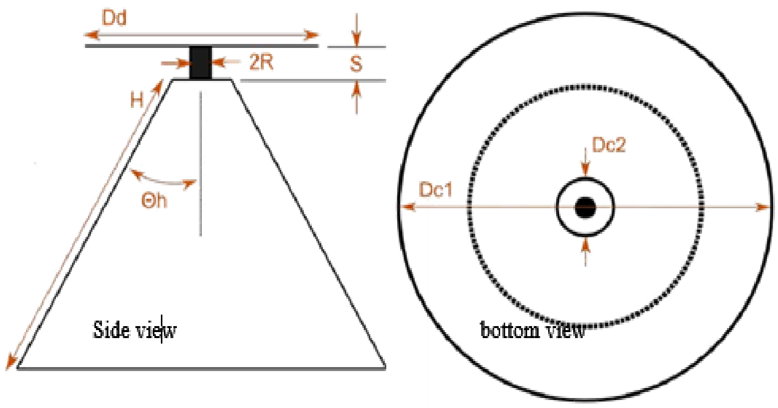


Figure 1: Discone Antenna side and bottom views

Parameters of Discone Antenna:

Name	Description
F_0	Center frequency
D_d	Disc diameter
R	Feed pin radius
S	Gap between cone and disc
Dc2	Diameter of the narrow side of the cone
H	Length of the cone side
Dc1	Diameter of the broad side of the cone
X	Diameter of the antenna
Y	Diameter of the antenna
Z	Height of the antenna
h	Cone flare angle

IMPLEMENTATION

Design objective

Name	**Description**	**Value**
f0	Centre frequency	15.13GHZ

Physical parameters

Name	**Value**
D_d	9.851 mm
R	35.24 µm

S	52.86 µm
Dc2	176.2 µm
Dc1	14.07mm

Derived quantities

Name	**Value**
X	14.07 mm
Y	14.07 mm
Z	12.29 mm
□h	29.59^{o}

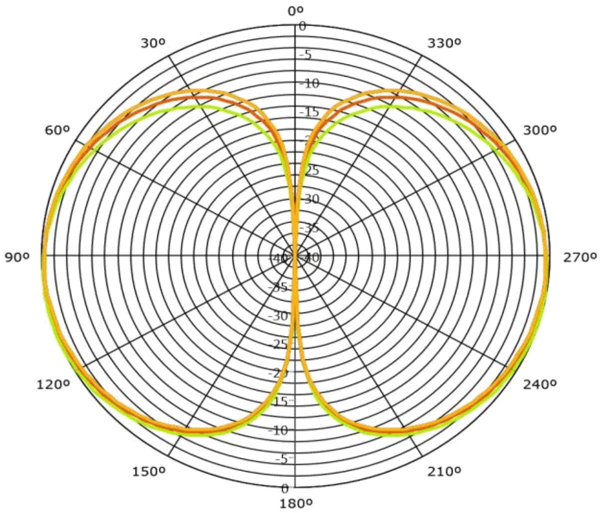
IV.RESULT

Radiation pattern in accordance with the arbitrary variations of H,R,S as followed.

Name	**Description**
H1	14.07 mm
H2	16.15 mm
H3	18.14 mm
R1	30.6 µm
R2	34.96 µm
R3	38.76 µm
S1	77.80 µm
S2	44.82 µm

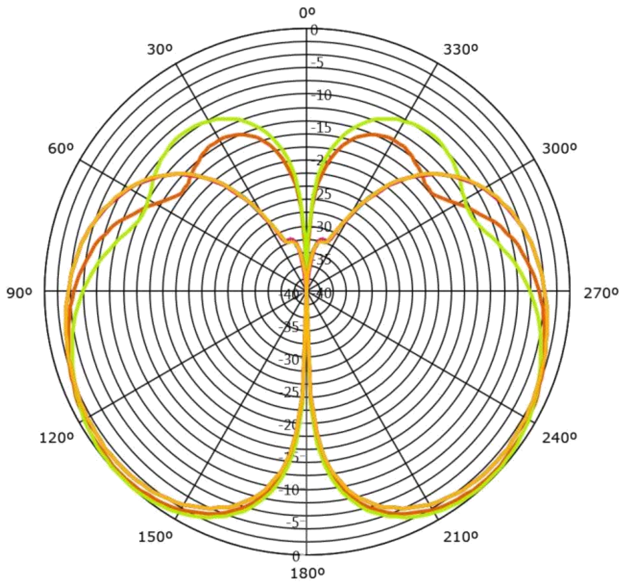
Radiation pattern of minimum frequency

Gain (Total-normalized)



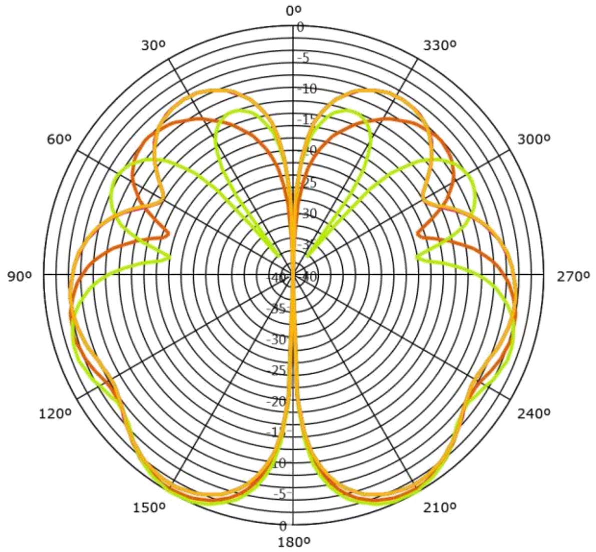
	H1	**H2**	**H3**	**R1**	**R2**	**R3**	**S1**	**S2**
Peak gain @ angle (freq) [□ = 0 °]	1.708 dBi @ θ = 98 ° (7.563 GHz)	1.897 dBi @ θ=102 ° (7.563 GHz)	2.170 dBi @ θ=-106° (7.563 GHz)	1.708 dBi @ θ=98° (7.563 GHz)	1.708 dBi @ θ = 98 ° (7.563 GHz)	1.708 dBi @ θ = 98 ° (7.563 GHz)	1.709 dBi @ θ=-98 ° (7.563 GHz)	1.707 dBi @ θ = 96 ° (7.563 GHz)
Main 3dB beamwidth (freq) [□ = 0 °]	91.93 °	86.75 °	80.38 °	91.94°	91.94 °	91.94 °	91.89 °	91.94 °

Radiation pattern at center frequency:



	H1	**H2**	**H3**	**R1**	**R2**	**R3**	**S1**	**S2**
Peak gain @ angle (freq) [φ = 0 °]	3.114 dBi @ θ=-132° (15.13 GHz	3.861 dBi @ θ=134° (15.13 GHz)	4.254 dBi @ θ=136° (15.13 GHz)	3.115 dBi @ θ=132° (15.13 GHz)	3.115 dBi @ θ=-132° (15.13 GHz)	3.115 dBi @ θ=132° (15.13 GHz)	3.122 dBi @ θ=-132° (15.13 GHz)	3.112 dBi @ θ=132° (15.13 GHz)
Main 3dB beamwidth (freq) [φ = 0 °]	71.48 °	59.54 °	52.97 °	71.48 °	71.48 °	71.48 °	71.35 °	71.53 °

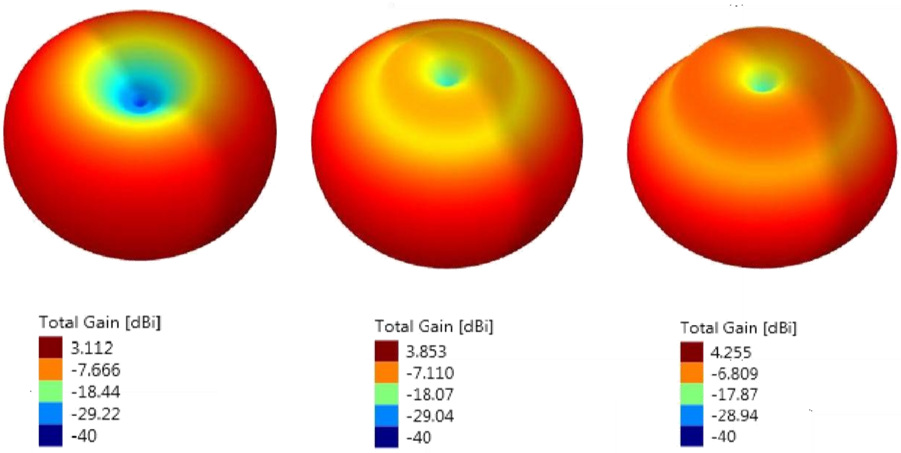
Radiation pattern at maximum frequency



	H1	H2	H3	R1	R2	R3	S1	S2
Peak gain @ angle (freq) [φ = 0 °]	4.503 dBi @ θ=150° (22.69 GHz)	5.238 dBi @ θ=-152° (22.69 GHz)	5.714 dBi @ θ=152 ° (22.69 GHz)	4.504 dBi @ θ=150 ° (22.69 GHz)	4.504 dBi @ θ=-150° (22.69 GHz)	4.505 dBi @ θ=150° (22.69 GHz)	4.508 dBi @ θ=150 ° (22.69 GHz)	4.501 dBi @ θ=150° (22.69 GHz)
Main 3dB beamwidth (freq) [φ = 0 °]	33.30 °	31.33 °	29.58 °	33.30 °	33.30 °	33.30 °	33.30 °	33.30 °

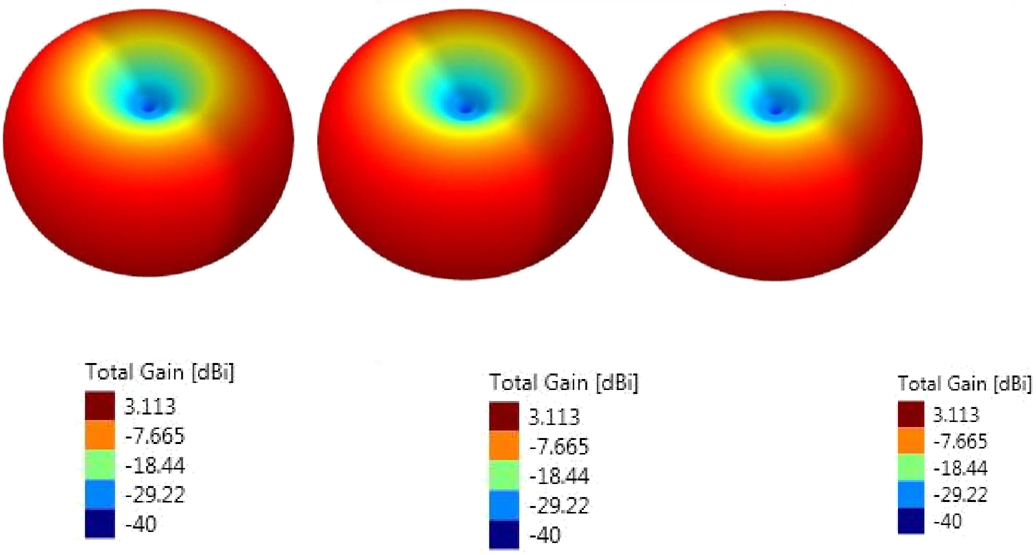
Radiation by varying length of the cone:

When h=14.07mm,16.15mm,18.14mm



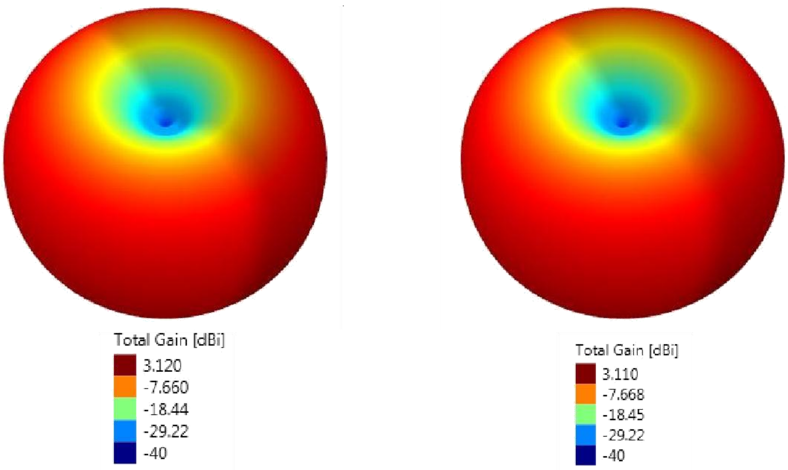
Radiation by varying feed pin radius:

When R=30.16µm,34.96µm,38.76µm



Radiation by Varying gap between Cone and feed pin radius:

When S=77.80µm,44.82µm



IV.CONCLUSION

The radiation pattern of the disccone antenna varies in accordance with the length of the cone side of the disccone antenna. The length of the cone side and its radiation pattern (gain) are inversely related. The gain pattern of the disccone antenna doesn’t depend on the feed pin radius. There is a slight variation observed with the change in gap between cone and disc. Gain of the antenna varies in proportion with gap between cone and disc. The discone's wideband coverage makes it attractive in commercial, military, amateur radio applications. The discone's inherently wideband nature permits it to broadcast undesirable spurious emissions from faulty or improperly filtered transmitters.

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