MEASUREMENT OF ATTENUATION DUE TO SCATTERING OF MILLIMETER WAVE SIGNAL FROM SAND DUNESOF THAR DESERT

Minaxi Vyas [1], Pragate Tomar [2], Sandeep Rankawat [3], D.R. Godara [4]

[1]*M.Tech Scholar, Digital Communication, Marudhar Engineering College, Rajasthan, (India)*
[2]*Assistant Professor, ECE Department, Marudhar Engineering College, Rajasthan, (India)*
[3]*Assistant Professor, ECE department, Engineering College Bikaner, Rajasthan, (India)*
[4]*Principle, Govt. Polytechnic College, Bikaner, Rajasthan, (India)*

ABSTRACT

Arid regions are defined as the parts of tropics that receive less than 250 mm of annual rainfall. The physical processes in these areas are completely different than other terrestrial regions and mainly involve soil erosion, saltation and sedimentation. The microwave signal attenuation caused by sand dunes is one of the major problems in utilizing microwave bands for terrestrial and space communication especially at desert and semi desert area. Due to the very large geographical sizes of deserts it has always been difficult to conduct detailed studies in such areas. Microwave observations are sensitive to the surface, volume, geometric, and dielectric properties of the target. During the last few decades, many scientists have investigated and related these observations to key geophysical parameters of the target surface. This paper provides a study of the sand dunes of Thar Desert and also collects sufficient data on signal attenuation at 35 GHz frequency due to signal propagation through sand dunes prevailing in the desert area of north-west part of India.

Keywords*: *Arid Regions, Microwavesignal Attenuation, Sand Dunes.

I. INTRODUCTION

The Thar Desert consists of large sand-dune fields which are variable shapes due to the wind action. The most common “sand dunes” known are the dunes made of quartz (SiO2) and feldspar (potassium KA, sodium Na or calcium Ca) particles found in the desert [1]. The erosion of granitic mountains creates small particles of silica that form the large dunes. All these dunes are sand dunes, even if the composition of the building material is very exotic. Sand actually refers to the particle size instead of the chemical composition [2]. The height of sand dunes is expected to be lower than most antenna heights of a microwave station [3].Signal attenuation is an important parameter in telecommunicationsapplications because of its importance in determining signalstrength as a function of distance. A major cause of this phenomenonis atmospheric particles which can seriously limit the performance oftelecommunication system especially at microwave level [4].The three main environmental factors that affect the height of sand dunes arewind speed, atmospheric stability, and surfacecharacteristics[5]. Scattering is the process by which small particles suspended in a medium of a different index of refraction diffuse a portion of the incident radiation in all directions. Scattering occurs when an electromagnetic signal encounters a surface that is large relative to the wavelength of the signal. Because the ground-reflected wave has an 180^0 phase shift after reflection, the ground wave and the line-of-sight (LOS) wave may tend to cancel, it results in high signal loss. Further, because the height of mobile antenna is lower than most human-made structures (like buildings) in the area, multipath interference occur. These waves may interfere constructively or

destructively at the receiver.Attenuation due to scattering recognized as a major cause of limitation of communication system operating atfrequency above 10 GHz. It constrains the path length of radio communication systems and bounds the use of higherfrequencies for line-of-sight microwave links and satellitecommunications.Power attenuated is measured with the help of spectrumanalyzer at the end of receiver system. The locations ofGovt. Engineering College Bikaner, Bikaner district ofRajasthan state are identified for extensive free-space point to point Path Loss, measurements in clear-sky and duringnatural weather conditions in Thar Desert region. Physicallocation of the transmitter and receiver systems heights of the transmitting and receiving antennas, distance between the transmitting and receiving antennas, and calculated Line of Sight (LOS) propagation link lengthsare perceived. Scattering from sand depends upon sand surface geometry and particle size characteristics (grain size distribution, electrical permittivity, etc.). So scattering from dunes is controlled by dune topography and incidence angle at which observation are taken at all frequencies and polarizations. The return signal from these surfaces is of more interest when incidence angle is equals to the angle of repose of sand, and the direction of measurement is perpendicular to the dune trend.

II. EXPERIMENTAL SET UP

The block diagrams of the transmitter and a receiver section of the millimeter wave system for operation at 35GHz is shown below. The millimeter wave link system consists a continuous-wave (CW) 35 GHz transmitter using a 100 mW Gunn source with a transmitting antenna of 18 degree beam width and 22 dB gain. The transmittersection is provided with modulating the RF carrier with 1 KHz square wave baseband signals from the carrier multiplex equipment. The modulated signal radiated through rectangular horn antenna connected to transmitter with rectangular waveguide and the modulating signal detected at receiver side. The transmitter communicates a maximum power of 20 dBm. The signal acknowledged by the horn antenna identical to the transmitter is down converted to the intermediate frequency (IF) followed by a cavity mixer with a local oscillator operating at 34 GHz. The IF of 1 GHz output of the mixer is fed to a pre-amplifier followed by a driver amplifier. The amplified IF signal is displayed on a spectrum analyzer (Micronics 3.3 GHz). The spectrum analyzer set in the auto mode shows both received power in dBm and central peak spectrum. The zero-span spectrum analyzer also allows the received power and spectrum to be saved into a laptop computer.

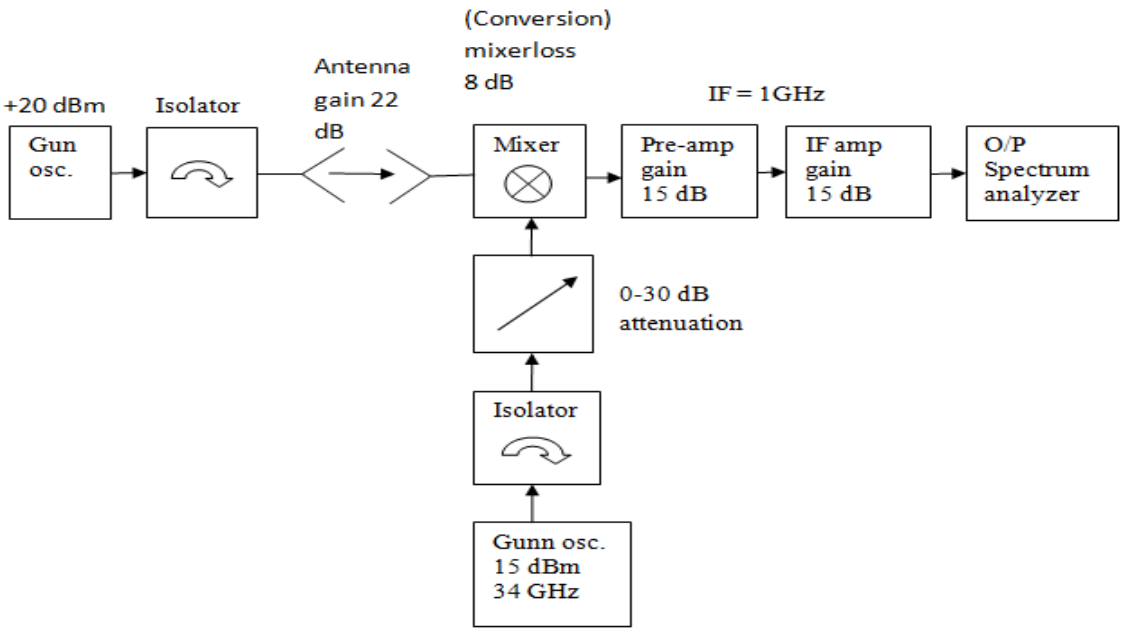

Fig 1 Block Diagram of Link System

III. AREA OF STUDY

The study area is Indian part of the TharDesert, which is located between 24° 36' – 29° 21' N Latitude and 69° 32' - 75° 26' E Longitude. The TharDesert in India is geographically, located in the state of Rajasthan, between the foothills of the Aravalli ranges in the east and the international border with Pakistan in the west [1].

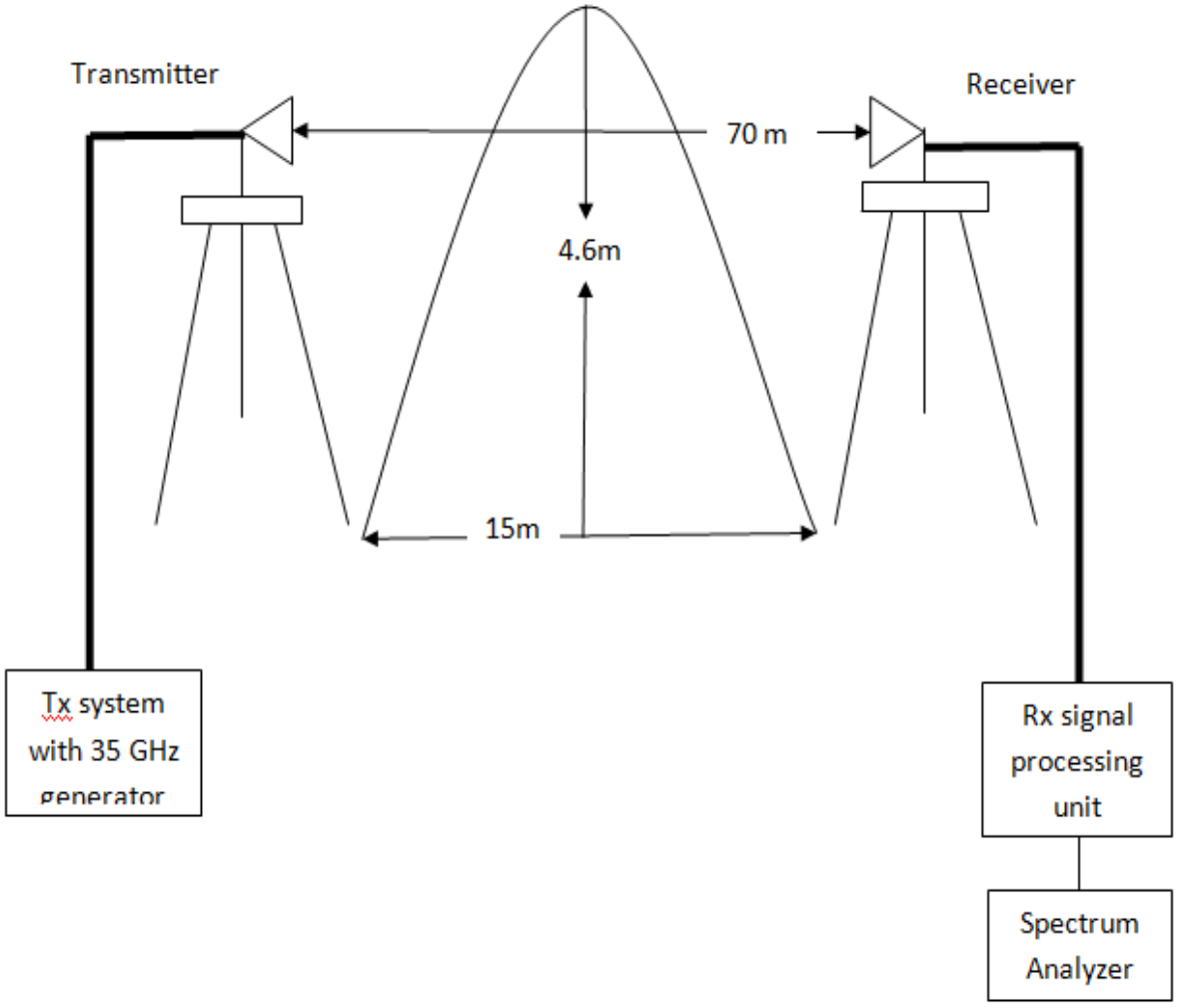

Fig.2. Measurement of Attenuation Due To Sand Dune

IV. SCATTERING BY SAND DUNE

Sand dunes exist in different shapes and sizes. Here In this experiment it is a dome shaped sand dune. Tx and Rx are positioned at a distance of about 35 meter from the center of dune. In first case position of Tx remains fixed and Rx rotates around dune in a circle of radius of 35 meter. Measurements are taken at different angular positions which are mentioned in tables below.

Place - Govt. Engineering College Bikaner (Bikaner) Temp - 36° C & Time - 11:20 AM

Height of sand dune - 4.6 meter Diameter of Sand dune - 15 meter

Transmitting and Receiving Antenna Height - 2 mWind speed - 6 km/hr.

Distance between transmitter & receiver - 70 m &Beam width - 18°

Table 1- Attenuation Due To Scattering by Sand Dune

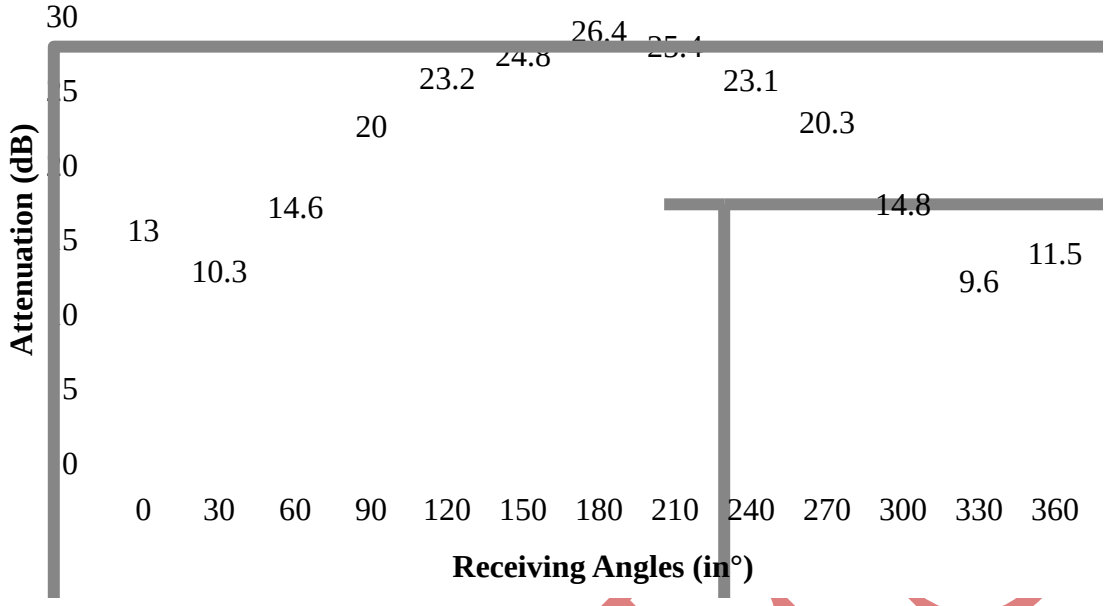

Fig.3. Attenuation at Different Scattering Angles

In scattering due to sand dune- there is very less power received at 180 degree scatter angle due to dense volume of sand dune. The experimental investigation into the millimeter wave at 35 GHz shows that scattering and absorption can cause signal attenuation of the order of 12–18 dB on the average and fades as deep as 30 dB or higher.

V. CONCLUSION & FUTURE SCOPE

A Field study is aimed at studying the scattering of millimetre waves was conducted to understand the effects of attenuation on short range radio links in view of the fact that millimetre wave frequencies in the region 26-40GHz have the potentiality to be applied for wireless broad band application to ease spectrum congestion problems. During scattering events the probability that attenuation rate exceeds as the angle between transmitter and receiver section set up increases going towards 180^0 and gradually decreases as the angle increases more. A maximum attenuation of 26.4 dB at 180° angle or at Line-of-sight angle and minimum attenuation of approx. at 30° and 330° anglesfrom both side of sand dune and signal will be attenuate till 16dBis observed. The amount of attenuation is depending upon sand particles, thickness of sand layers and incident angle on dune. In the future work, comparison with other types of foliage, many scattering prediction models can be done. Variation of attenuation due to scattering with different foliagewith high environmental temperature and arid climate can also be studied. An algorithm for power saving on the transmitter which provide save the power when environment will be changedcan be designed. We see in measurement in scattering due to sand dune there is very less power received at 180° scatter angle due to dense volume of sand dune. So we can improve received power at 180° by the power algorithm.

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