Effect of Foliage Length on Signal Attenuation in Millimeter Band at 35GHz Frequency

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ABSTRACT
The appearance of the foliage medium in the path of the communication link in Millimeter band has found to play a significant role on the quality of services for wireless communication. In this paper an attempt has been made to quantify the signal attenuation of microwave signal at 35 GHz due to varying foliage length so the communication with any degree of confidence can be assured in a foliage environment. It concludes that the signal attenuation doesn't increase linearly as the number of trees or the length of foliage increases. For the measurement of signal attenuation, a Gunn oscillator trans-receiver system of 35 GHz (100mW) is used.

Keywords
Millimeter wave, broadband, antenna, modulation, demodulation, power amplification, signal attenuation.

1. INTRODUCTION
The millimeter wave spectrum (30-300GHz) is of increasing interest to service providers and systems designers because of the wide bandwidths available for carrying communications at this frequency range. Such wide bandwidths are valuable in supporting applications such as high speed data transmission and video distribution. To fulfill the increasing demand of high rate data and wideband communication, Ka band (26-40GHz) is under consideration. For the establishment of more and more communication system in the millimeter wave band it becomes necessary to study the propagation attenuation due to various parameters of foliage. The Planning of millimeter wave spectrum use must take into account the propagation characteristics of radio signals at this frequency range [1]. The signals at lower frequency bands can propagate for many miles and penetrate more easily through vegetation and foliage, millimeter wave signals can travel only a few miles or less and do not penetrate solid material very well[4]. The difference in foliage penetration for 10 GHz and 35GHz is not dramatic, while for 90GHz it is considerably higher. This leads to the result that the 35GHz band is well suited for fire detection behind foliage [9]. Millimeter waves can permit more densely packed communications links, thus providing very efficient spectrum utilization, and they can increase security of communication transmissions. Attenuation due to foliage and vegetation has long been recognized as a major limitation to reliable communication system operating at frequency above 10 GHz [2]. It restricts the path length of radio communication systems and limits the use of higher frequencies for line-of-sight microwave links. The objective of this research work is to collect sufficient data on signal attenuation at 35 GHz frequency due to signal propagation through foliage prevailing in the desert area of north-west part of India. These data can be used to generate algorithm to control the microwave link transmission power so that in favourable conditions it transmits minimum power and during adverse conditions like foliage with fog, it may transmit sufficient power to ensure reliable communication.

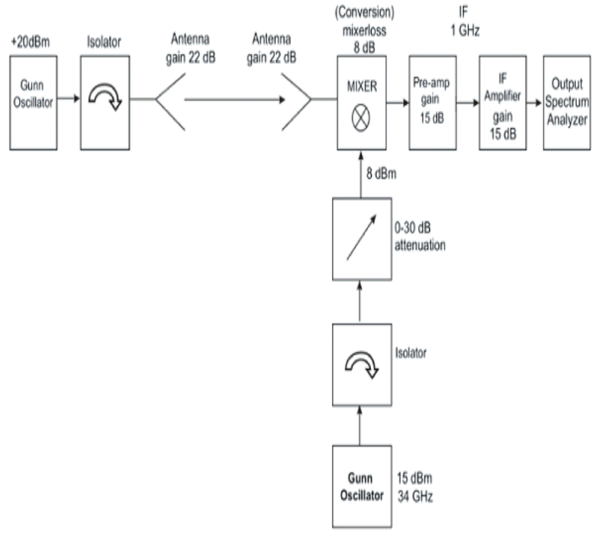

Fig1. Block Diagram of 35 GHz Link System

2. EXPERIMENT SETUP

Fig 2.Experimental site at Govt. Engineering College Bikaner

The block diagram of the transmitter and receiver sections of the 35GHz system are shown in figure1. The millimeter wave link system comprises a continuous wave 35 GHz transmitter using a 100 mW (20dBm) Gunn source with a transmitting antenna of 18 degree beam width and 22 dB gain.

The receiver section has the requisite down conversion and de-spreading circuitry. The signal received by the horn antenna is down converted to the intermediate frequency (IF) followed by a cavity mixer with a local oscillator operating at 34 GHz. The IF of 1.0 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. The spectrum analyzer shows both received power in dBm and central peak's frequency. The spectrum analyzer also allows the received power and spectrum to be saved into a laptop or computer. Receiver is capable of providing a useable base band output with received millimeter wave signal levels as low as -80 dBm.

During this experiment, the signal attenuation measured with respect to the number of Neem trees of almost same size. The five trees were considered one by one in the path between transmitter and receiver. The observations show that 26.3dB attenuation was found when five trees of equal depth (5 feet) and height (7 feet) each were in the path. The attenuation versus number of Neem trees measurement result shows that initially high attenuation and then becoming more gradual after three trees. It means that the signal is attenuated as it travels through these trees, but also as the signal passes through several trees it becomes randomly polarized explaining the gradual transition in attenuation. There is a gradual increase in attenuation with the increasing in number of trees.

Result and observations

Canopy Size (Neem) = Height 7feet

and canopy size 5feet.

Gunn Voltage = 3.87 Volt

and Current = 0.53 Ampere

IF frequency = 1.08GHz,

Reference Level = -12dBm

Height of Transmitting and Receiving Antenna = 7 ft.

Table:1 Attenuation with different number of trees

No. of Trees	Distance in feet	Received Power LOS (dBm)	Received Power LOS with foliage (dBm)	Attenuation (dB)
1	39	-37.3	-43.7	6.4
2	57	-39.9	-52.1	12.2
3	75	-41.3	-60.1	18.8
4	93	-43.3	-66.5	23.2
5	111	-46.3	-72.6	26.3

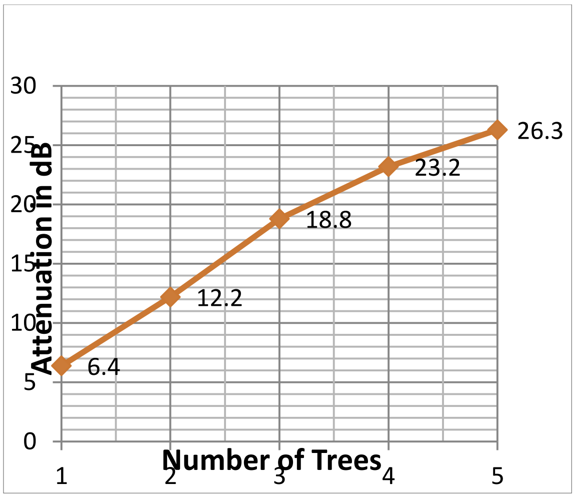

Fig 3. Signal attenuation with number of trees

3. CONCLUSIONS

The observations taken during present work concludes that the signal attenuation at 35 GHz is not increasing proportional to the number of trees or the foliage depth. The effect of foliage length in the path of a point to point link influence the received signal as by providing an additional attenuation to that of free space but due to scattering and depolarization of signal by longer foliage length results in lateral contribution to the received signal. The experimental result shows that for foliage length 5feet, the signal attenuation is1.28 dB/ft and for foliage length 25 feet, the signal attenuation is1.052 dB/ft.

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