World Scientific News

The zigzag pattern construction of Log Periodic Dipole Antenna Based on Rumsey's Principle

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ABSTRACT

The log-periodic dipole array (LPDA) consist of an array of dipoles in which there have a different lengths and spacing. The wire may be straight or it may be strung back and forth between trees or walls just to get enough wire into the air; this type of antenna sometimes is called a zigzag antenna. Rumsey's principle requires that the locations of all elements be specified by angles rather than distances, because of this the log periodic dipole array must be correspondingly longer to get very wide bandwidths and gives a very high data rate transmission. The significance of this study is to understand how do the LPDA can be used to monitor solar activities of the sun using the LPDA antenna. The characteristics that need to be considered during construct this antenna is the radiation pattern, polarization, operation of the frequency band, gain and efficiency of an antenna which indicates the power or field strength radiated in any direction relative to that in the direction of maximum radiation. The arrangement of elements in increasing order from the top of the antenna until the bottom part of antenna. Our designed antenna was constructed using aluminum for the further investigation, we can use a copper and check the difference between two of this element. For this study, we just analyzed the source of RFI using this antenna and for the further analysis, we can use this antenna to monitor the solar burst.

Keywords: Log Periodic Dipole Antenna; zigzag pattern; solar burst; radio region; Rumsey's principle

1. INTRODUCTION

In radio astronomy, one of the challenges of the next generation radio telescope for astronomy is the capacity of the scope with increasing polluted of RFI [1,2]. For that purpose, we need to design the high efficiency of the antenna. The previous antenna should be improved in term of stabilization- mechanical aspect. The type III solar burst that associated with solar flare normally in a wide region (45-1000 MHz) [3,4]. Therefore, we need to modify the range of frequency. 45-870 MHz (previous) to 45-1000 MHz. The log-periodic dipole array LPDA consist of an array of dipoles in which there have different lengths and spacing [5,6]. The wire may be straight or it may be strung back and forth between trees or walls just to get enough wire into the air; this type of antenna sometimes is called a zigzag antenna. However, the radiation pattern of a straight random wire antenna is unpredictable and depends on its electrical length; its length measured in wavelengths (λ) of the radio waves used [7].

The antenna positioned facing the sun during the daytime. Logarithmic periodic dipole antenna (LPDA) was designed to precisely match the environmental requirements [8,9]. The special cable is needed for transfer signals in the radio frequency regime (1-100 MHz) preferably lossless for the outdoor purpose, we use RG-8 cable and we use either the radio frequency (RF) transformers for impedance transformation between the antenna and the cable [10,11]. For frequency-independent operation, Rumsey's principle has been verified in spiral antennas, conic spiral antennas and some log periodic antennas . Rumsey's principle requires that the locations of all elements be specified by angles rather than distances, because of this the log periodic dipole array must be correspondingly longer to get very wide bandwidths and gives a very high data rate transmission. The most popular theory was introduced by Victor Rumsey in the 1950s to explain a family of so-called frequency-independent antennas. Rumsey's principle suggests that the impedance and pattern properties of an antenna will be frequency independent if the antenna shape is specified only in terms of angles. The information is stored in a simple ASCII, which can be analyzed with any spread sheet like IDL, Math-CAD or EXCEL. In order to get the pure signal we need to know some theoretical aspect and parameter for evaluation. For the beginning, we found the relationship between element factor (τ) with the size of the element represented [12]. This requirement makes frequency-independent antennas quite large in terms of wavelength [13].

Gain as one of the parameter measures the directionality of a given antenna. An antenna with a low gain emits radiation in all directions equally, whereas a high-gain antenna will preferentially radiate in particular directions. Specifically, the Gain or Power gain of an antenna is defined as the ratio of the intensity (power per unit surface) radiated by the antenna in a given direction at an arbitrary distance divided by the intensity radiated at the same distance by a hypothetical isotropic antenna. By referring the equation of scale factor and spacing factor we can find the equation of the of gain which is τ / σ.

The significance of this study is to understand how do the LPDA can be used to monitor solar activities of the sun using the LPDA antenna. We will construct our own LPDA antenna using aluminum rod. The modification of this antenna will give a wide range of frequency from 40MHz-1000MHz instead of 45MHz-870MHz (previous antenna). This study will focuses on preparation and performance of the (LPDA) antenna as well as the characteristic of CALLISTO spectrometer as receiver in observation of solar flares and Coronal Mass Ejections (CMEs) [14]. The data in this study might be used by authorities to monitor and analyze the signals from the sun [15].
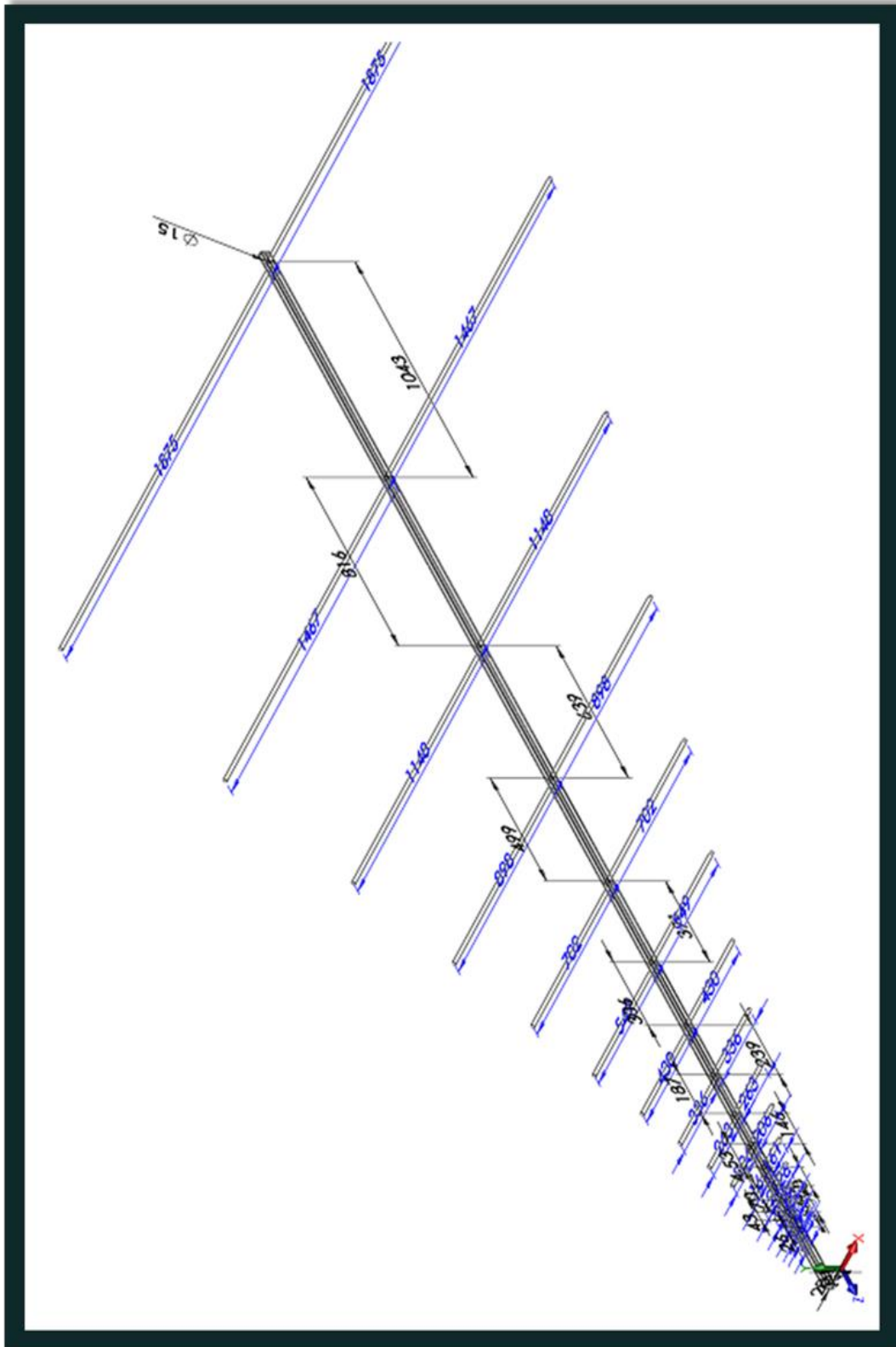
Figure 1. Antenna design

2. ANALYSIS OF ANTENNA TEMPERATURE

IEEE defines bandwidth as "The range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard. In other words, bandwidth depends on the overall effectiveness of the antenna through a range of frequencies, so all of these parameters must be understood to fully characterize the bandwidth capabilities of an antenna. This definition may serve as a practical definition, however, in practice, bandwidth is typically determined by measuring a characteristic such as SWR or radiated power over the frequency range of interest. For example, the SWR bandwidth is typically determined by measuring the frequency range where the SWR is less than 2:1. Another frequently used value for determining bandwidth for resonant antennas is the -3dB Return Loss value. Data transmission at higher rates requires wider bandwidths for the elements constituting a communication link. This required wideband antenna be designed and used. The calculation of bandwidth as show below.

The β_s bandwidth spacing equal to product between the (β) bandwidth factor and (β_{ar}) bandwidth active region.

The bandwidth of active region calculation.

$$B_{at} = .1 + 7.7 \ (1\text{-}\tau)^2 \cot \alpha \tag{1}$$

The maximum λ of this antenna can be measured by equation below. The maximum λ is the is the length of the minimum frequency. The highest frequency has the minimum λ we can assume that the frequency that can be detected by the antenna is between the highest and the lowest (O. I. Madikwane, 2006).

$$\lambda_{max} = 2 \, l_{max} = \nu \ / \ f_{min} \tag{2}$$

Because this antenna supposed to be located outdoor, we chose the aluminum type and the insulator of this antenna is PVC. Aluminum and PVC are the material that can withstand from rust as it has a protective oxide coating which quickly forms on freshly exposed aluminum. Another reason this material has been chosen because it is expensive, it is easy to handle as it is light in weight. Due to the length of the antenna, with multipath propagation there is a diversity effect; radio waves which interfere and cancel at one part of the antenna may not cancel at another part, resulting in more reliable overall reception.

We cut it in different sizes based on frequency. The dimension of the antenna is based on the frequency that we decide to observe. The 17 elements are arranged in an array on the boom. The width and spacing of this antenna increase and decrease smoothly according to the specification. The maximum length is 1875 mm and the minimum length is 37mm. Length of this antenna is 4698 mm so the maximum of the distance between the first element and the last element is 4698 mm. It is hoped that this technique has focused on optimizing the accuracy and dynamic range achievable in the continuous burst by suppressing DE convolution errors that arise when the spectral structure of the sky-brightness is neglected. Make sure that the low frequency-dependence of radiation pattern and input impedance (Z. Hamidi & Shariff, 2014).

Two array may be stacked to get more gain The diameter of these rods and tubes were chosen so as to incorporate the compactness as well as the ease of assembly for the antenna

elements. All the aerials are polarized since we dealing with transverse waves. Make sure the directivity of this antenna is concentrated to the point of zenith direction, because this antenna is not automatically tracking yet. In this direction the radiation of the Sun is maximum and the LPDA antenna more stable [16].

3. RESULTS AND ANALYSIS

The performance of the antenna might affect by the some basic parameter. By determine the power flux density of the burst we can improve the performance of the LPDA antenna and get the best picture. The nearest sources are one of the factors that will affect our LPDA performance. The characteristics that need to be considered during construct this antenna is the radiation pattern, polarization, operation of the frequency band, gain and efficiency of an antenna which indicates the power or field strength radiated in any direction relative to that in the direction of maximum radiation.

The LPDA antenna is formed of the coplanar linear array of unequal and unequally spaced parallel linear dipoles fed by a twisted balanced transmission line. It consists of small, closely spaced half-wave dipoles. The twin transmission line is used to connect this dipole to the source in such a way that the phase is reversed at each connection relative to the adjacent elements. The length of the antenna is effective to detect the narrow band of frequency.

In this study, we have built the LPDA antenna to be analyze the characteristic and the best way to get the very efficient signal from the source. we have choose the dipole array which is consist of sequence of side by side patroller linear dipole forming the coplanar array ("antenna & propagation laboratory," n.d.). This antenna has slightly smaller directivity than the Yagi –Uda array, but they are achievable and maintained over much wider bandwidths. The length (l_n 's),spacing (R_n 's),diameter (d_n s) and event the gap of the spacing at dipole center antenna (s_n s) array increase logarithmically as define by the inverse of the geometric ratio τ.

Refer to Figure 3, the feed arrangement of crisscross connect will produce the input feed line which is a balance line like the two –conductor transmission line. Practical method using the coaxial cable as a feed line to achieve the 180° phase between adjacent elements. To balanced overall system, this feed arrangement provides a built- in broadband balun. Usually piping is used to make the element and the feeder line of this array. The coaxial cable is used to feed through the hollow part of the feeder-line pipes. Outside conductor of the coax is connected to the conductor at feed and inner conductor is extended and connect to other pipe of the feeder. In this experiment we use the crisscross connection.

The wooden block has been used as an insulator to separate between two booms. Each boom has their own function which is gaining signal and another one emitted a signal. The aluminum is arranged with different length of the this boom and act as an element.

The arrangement of elements in increasing order from the top of the antenna until the bottom part of antenna. The length and distance were arranges according to the specification on the Figure 6. The insulator was put in between two booms, avoid them from touching each other.
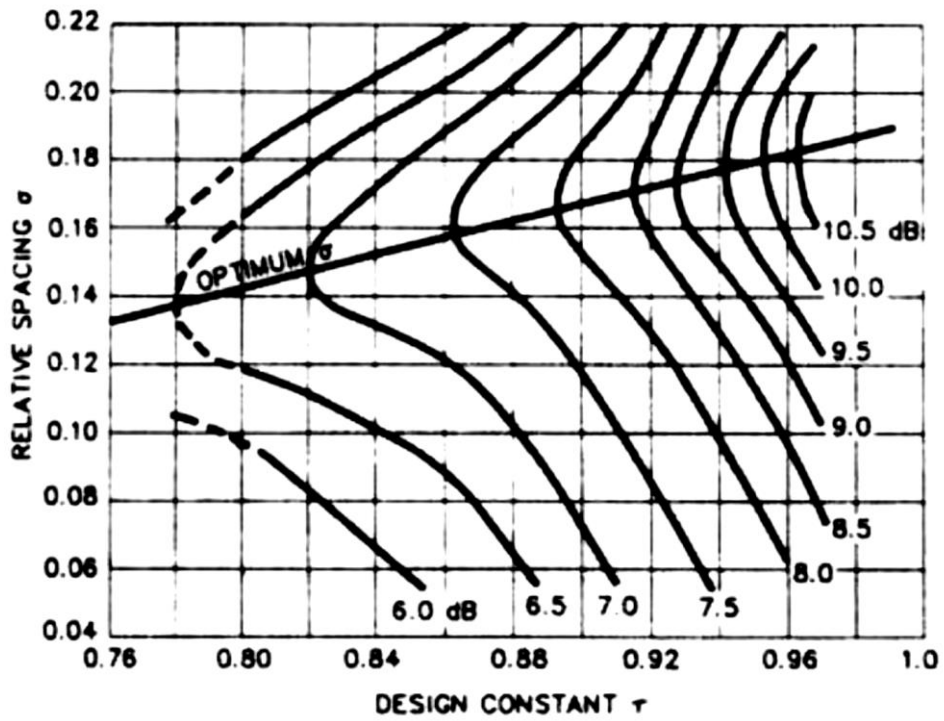
Figure 2. Selecting the scale factor, τ = 0.8

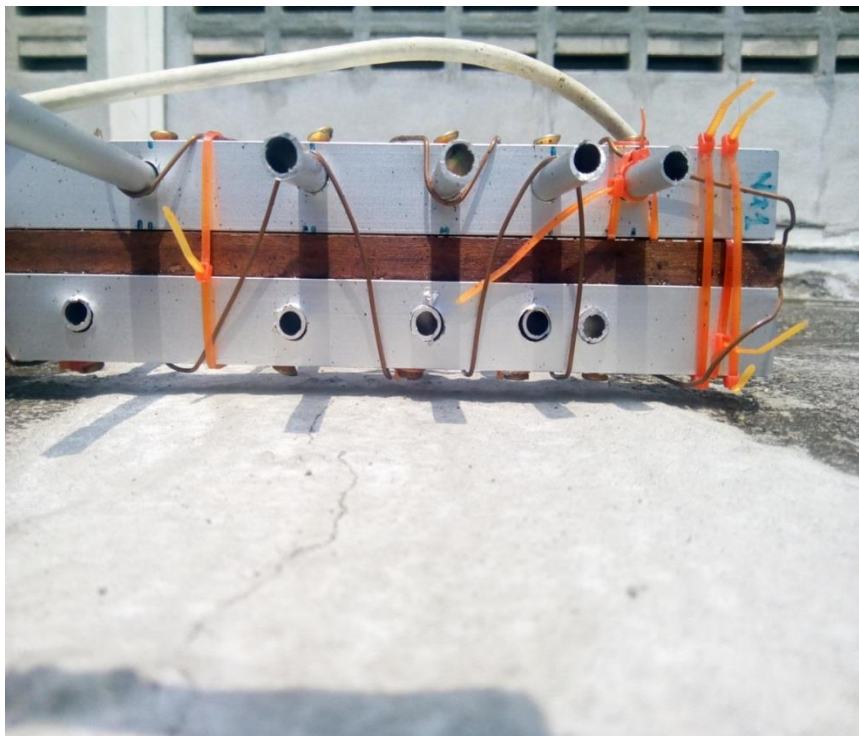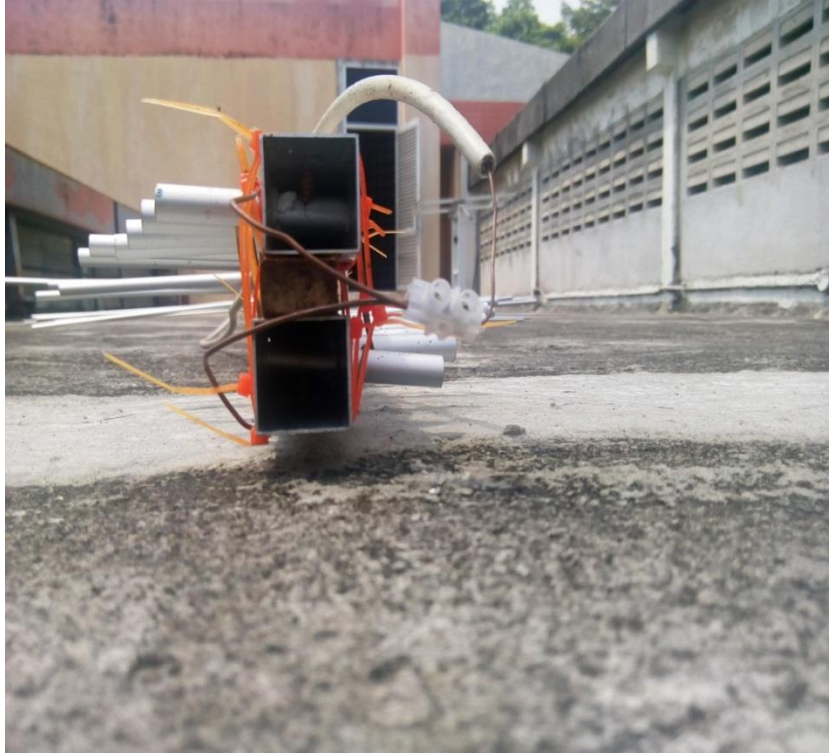**Figure 3.** Spacing factor σ = 0.14

Figure 4. Crisscross connection using the copper wire.
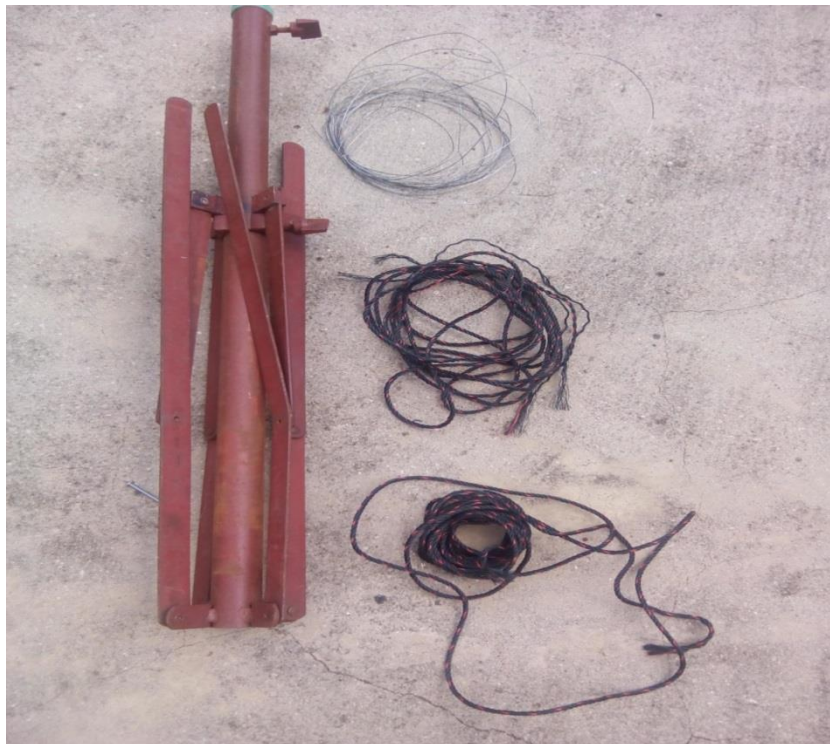
Figure 5. Connection of balun to the coaxial cable

Figure 6. Arrangement of element on the boom.

Table 1. The function of component of antenna

Component	Function
Tripod	Three-legged stand for supporting antenna up
Wire	Use to tight the antenna with the tripod
Rope	Support the antenna and act as resistant from wind

Figure 7. Tool to support the antenna

This supporting tool provides the strengthened to the antenna during windy days .The rope must be belted firmly on the antenna body to avoid it from falling. The tripod leg must be placed on the flat surface and using wire to tie the bottom of the antenna to this tripod leg.

An antenna should be mounted at the point where the signals are the strongest, though often this is impractical or impossible. The antenna should also be mounted where it can be easily serviced should repairs or adjustments be required in the future. There are many acceptable locations where an antenna can be mounted such as on the roof, in the attic, on a wall, on the angle of the house and even on the ground. Having a clear line-of-sight is the most importantconsideration, butt carefully "aiming" (orienting) the antenna and adjusting its height often can overcome the problems created by installing it in a slightly weaker signal

area. In an area where there is a relatively short, the unobstructed signal path between the installation and the transmitting towers, we can mount the antenna just about anywhere and receive sufficient signal. As we move deeper into the fringe areas, however, there may be significant differences in signal strength at various points around your home. This is where careful antenna selection, precise orienting, and accurate adjustment of the height become essential. Typically, you should be able to locate a spot where there is both a usable signal and sufficiently easy access to the antenna. Large trees, tall buildings and obstructions can present reception problems. Nearby high-voltage power lines can also cause interference that cannot be completely eliminated. Consequently, the further the antenna is from large trees, buildings, obstructions and high-voltage lines, the better the reception will be.

4. CONCLUDING REMARKS

In this study, the log periodic dipole antenna just covering a frequency range of 45-1000 MHz with required high gain is designed and then simulated by HFSS simulator. This simulator helps us to see the pattern of radiation of out antenna and we also can see clearly the difference radiation in each frequency. We construct out antenna element using aluminum, which is can conduct the electric and have corrosion resistance, because of this it can withstand with a lot of condition and weather, This is proved by observation of the body of the antenna when it works with the outdoor environment, there is no corrosion on the antenna. Our designed antenna was constructed using aluminum for the further investigation we can use a copper and check the difference between two of this element. For this study we just analyzed the source of RFI using this antenna and for the further analysis, we can use this antenna to monitor the solar burst.

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