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Modification and Performance of Log Periodic Dipole Antenna

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Abstract—Technological advances and developments in solar activities, particularly in solar radio bursts, have created a demand of constructing log periodic dipole antenna (LPDA) to monitor this phenomenon in radio region. In this paper, we make an effort in designing a portable LPDA that suitable with the criteria, specification and practical enough although is the boom length size of the antenna is 3.11meter. This initiative is to modify so that it will be more portable and established enough. We choose value of 0.08 spacing factor τ= 0.8 as a directivity of antenna. The performance of this antenna will also be discussed.

Index Terms—Log Periodic Dipole Antenna (LPDA), signal detection

I. INTRODUCTION

Technological advances and developments in solar activities, particularly in solar radio bursts, have created a demand of constructing log periodic dipole antenna (LPDA) to monitor this phenomenon in radio region. In principle, antennas can be used to transmit or receive electromagnetic waves. The properties in both cases are the same due to the principle of reciprocity. Among the types of antennas, LPDA have attracted much attention lately due to the broadband frequencies. During recent years, logarithmically periodic antennas have been widely used due to their frequency response characteristics, simplicity of design and directivity [8]. It also part of ISWI (International Space Weather Initiative) project in order to monitoring the solar activity 24h/7d coverage of solar observations in state of support develop countries participate internationally with a latest technologies of instrument [1]. In our work, we need to construct an antenna to monitor solar burst in radio region. These bursts can best be distinguished in spectrometer, as demonstrated already. In the meter wavelength range, 5 types of radio emissions are distinguished and at decimeter wavelengths there is a similar number [2, 3]. The Log Periodic Dipole Antenna (LPDA) plays an important role in the modern communication and radar system [7]. Development of LPDA has started since 1961 initiated by Isbell [6]. Later, Carrel analyzed the LPDA mathematically and computed its radiation pattern, input impedance, etc., using a digital computer [9]. It must be sensitive to a broad frequency range and angular distribution of the incident radio pulse. On the other hand, it plays an important role in handling the noise issue and thus is essential to detect preferably pure signals. One main criteria that make LPDA become more relevant is due to it sensitivity that possible to detect signal of the Sun. Moreover, it also economical and practical to be implements.

Our first construction of LPDA has successfully been setup at National Space Centre, Banting on 21st February 2012. This antenna focused in 45 MHz till 870 MHz. although we could obtain a good data of solar burst; there is still improvement that needs to be done. Due to long boom length, approximately 5.5 meter, its make antenna become not practical for portable purpose. In addition, we still need to improvised by reduce the length of the cable which been quite long to the detector. Our previous antenna also not covered the range below than 80 MHz where this situation will limit the detection of low frequency of solar. Since radio waves at frequencies < 150 MHz from the Sun originate primarily in its corona, observations of polarized solar radio emission can be used to derive information about the magnetic field in the corona. The lightning protection of the antenna also should be concerned by used other material at the top of the antenna. Low antenna impedance problem can be olve by designing dipole and folded dipole antennas because they shows higher antenna impedance than monopole antenna but planar diversity folded dipole and M-slot folded patch antenna has lower gain in associated application [5].

For the further treatment of the received data, a precise knowledge of the antenna characteristics is necessary. A detailed characterization of the mentioned logarithmic periodic dipole antennas is one major objective. Therefore, we plan to modify the antenna by considering the same range of frequency but can be used portably. We choose a range from 45MHz till 1000 MHz but the length of the antenna reduce to 3.11meter. In this paper, we make an effort in designing a portable LPDA that suitable with the criteria, specification and practical enough to observe the solar activities daily.

II. SPECIFICATION OF THE LOG PERIODIC DIPLOLE ANTENNA (LPDA)

Here, we summarized the various aspects of the antenna system, digital hardware, the data acquisition and receiver front is presented in this section. Figure 1 showed the schematic diagram of LPDA. A total of 38 elements will be that represent specific frequency will be constructed for two (2) boom. We choose to use a plastic material as an insulator. The diameter of the insulator is 30mm x 18mm. This size is better enough compared to our previous antenna which is 10 x10 mm only. We also choose value of 0.08 spacing factor τ= 0.8 as a directivity of antenna. This log periodic dipole antenna directly control via low loss coaxial cable type RG8 to the CALLISTO spectrometer. The Compact Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) has been described in detail by Benz et al. [2,3]. CALLISTO spectrometer will convert the high-frequency electromagnetic signals into a form convenient for detecting and measuring the incoming radio emission. With large instantaneous bandwidths and high spectral resolutions, these instruments will provide increased imaging sensitivity and enable detailed measurements of the dynamic solar burst. We also used the preamplifier ~20dB for amplification purpose. As a part of data acquisition, CALLISTO software and RAPP JAVA Viewer will be used. We also can use IDL program to analyze the data. The specification of the antenna is described in Table 1.

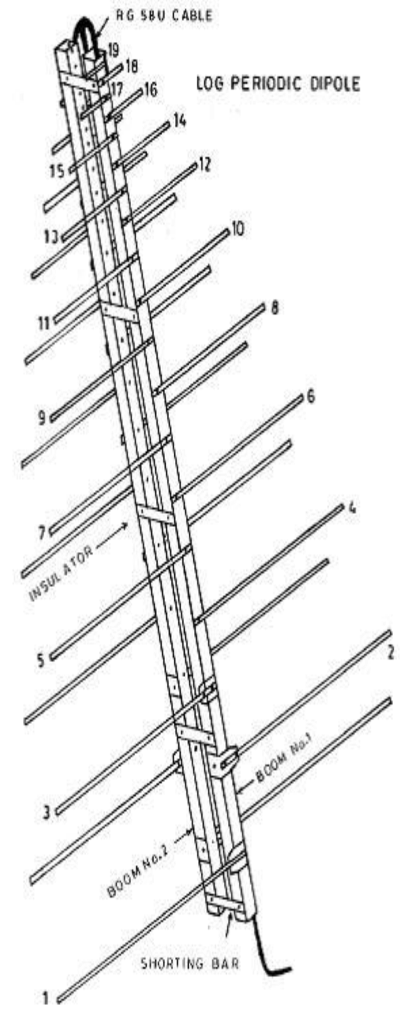

Fig 1. Schematic diagram of LPDA

Table I : Overall Performance For The Car Sequence

No of elements	L	R	d
1	3.96	*3.17*	0.64
2	*3.17*	*2.54*	0.50
3	*2.54*	*2.03*	0.40
4	*2.03*	*1.62*	0.32
5	*1.62*	*1.29*	0.26
6	*1.29*	*1.04*	0.21
7	*1.04*	*0.83*	0.16
8	*0.83*	*0.66*	0.13
9	*0.66*	*0.53*	0.11
10	*0.53*	*0.43*	0.09
11	*0.43*	*0.34*	0.07
12	*0.34*	*0.27*	0.05
13	*0.27*	*0.21*	0.04
14	*0.21*	*0.17*	0.03
15	*0.17*	*0.14*	0.02
16	*0.14*	*0.11*	0.21
17	*0.11*	*0.09*	0.017
18	*0.09*	*0.07*	0.014
19	*0.07*	*0.06*	0.011

III. RESULTS AND DISCUSSION

The log periodic dipole antenna for the range 45–1000 MHz (Low Frequency Broad Band) is a stationary inverted V dipole, on the east-west vertical plane. Each leg has a length of 3.1 m with maximum a width of 1 m. At present this LPDA has been operated at Physics Department University of Malaya located at 3°7′51″N 101°40′10″E. For calibration purpose, this antenna is disconnected from the system and a white noise generator (constant,T = 10^4 K) is connected. The duration of the calibration is about 1 min and the signal is recorded. The main purpose to get this signal is used to recognize the whole system behavior and to calibrate it. After the end of the calibration the antenna is connected again to the system. The values of scale factor (τ), subtended angle (α), and spacing factor (σ) are chosen so that the resulting gains can be compared to the constant directivity contours for LPDAs by Carrel [4].

Table II : Comparison of LPDA modification with the previous antenna

Frequency range	80 MHz to 870 MHz	45 MHz to 1000 MHz
Polarization	linear	linear
Input impedance	50 Ω (unbalanced)	50 Ω (unbalanced)
Standing wave ratio (VSWR)	1 ≤2	1 ≤2
Spacing factor	0.14	0.08
Gain	6.5 dBi	10 dBi
RF connector	N connector	N connector
Antenna length	5.45 m	3.11 m
Max. antenna width	1.98 m	1.98 m
Weight	6 kg	4.2 kg
Lightning protection	Yes	Yes

The antenna is mounted horizontally on a steerable azimuth/elevation tower and controlled by the computer to automatically point the sun during the day time. Beside the established detection techniques, the construction of antenna also needs to be improved. Logarithmic periodic dipole antenna (LPDA) was designed to precisely match the environmental requirements. The used LPDA play a key role for the successful detection of solar burst as they provide the sensitive component of the radio detector. The Callisto spectrometer e-C07 having a detector sensitivity of 25mV/dB including control cables and rf adapters was supplied by ETH Zurich. Meanwhile, the frequency range of CALLISTO spectrometer ranges from 45MHz to 870MHz in three (3) sub bands. The channel resolution is 62.5 kHz, while the radiometric bandwidth is about 300 kHz. The sampling time is exactly 1.25msec per frequency-pixel while the integration time is about 1msec. The frequency in the output data is expressed in MHz and the detector output is expressed in millivolts. To transfer signals in the radio frequency regime (1-100 MHz) preferably lossless, special cables are needed. We used RG-8 cable for outdoor purpose. At this location an additional measurement was taken when applying a 50Ω resistor to the antenna terminal as a reference level to evaluate the power level in dB above this broad- band load (a termination resistor at ambient temperature in the order of 300Kelvin). Both are stored in a simple ASCII which can be analyzed with any spread sheet like IDL, Math-CAD or EXCEL. By improving the method of construction, we will achieve a deeper understanding of the mode of operation of LPDAs by measurements of the electrical transactions within the antenna structure and of single components of LPDAs. Our next plan is to attempt different test setups will be used to benchmark both, the electrical and mechanical performance of the LPDA concerning low region of radio frequency.

IV. CONCLUSION

Concerning the objective to expand the low limit of the receiving frequencies is to investigate more detection of solar burst to very low frequencies; it is become possible with the construction of LPDA. It could not be denied that the radio detection of solar activities in radio region makes various demands on the used antennas. We also managed to improvise the value of gain with 10 dB compared to the previous one 5.71 dB. We will motivate the electrical and mechanical conception of the used LPDAs as a consequence of a precise adjustment of the antenna properties to the demands of radio detection for the next construction. The daily operation is fully automated: receiving universal time from a GPS, pointing the antenna to the sun, system calibration, starting and stopping the observations at preset times, data acquisition, and archiving on database. This antenna can be used either permanently or portably to study the onset and evolution of solar radio bursts and associated solar flare phenomena. Up to date, we have shown the improvement of the LPDA construction. Our next task is to monitor the Sun activities, compare with the other sites and make a solar burst model for the long term project.

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