SOLAR RADIO SPECTRO-POLARIMETRY (50-500 MHZ) : DESIGN AND DEVELOPMENT OF CROSS-POLARIZED LOG-PERIODIC DIPOLE ANTENNA.

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Introduction: A radio spectro-polarimeter was developed at the Gauribidanur radio observatory (Longitude : 77◦27′07″; Latitude : 13◦36′12″) to study the characteristics of the polarized radio waves that are emitted by the impetuous solar corona in the 50 - 500 MHz frequency range. The instrument has three major components : a Cross-polarized Log-Periodic Dipole Antenna (CLPDA) [1], an analog receiver, and a digital receiver (spectrum analyzer). This article elaborates the design and developmental aspects of the CLPDA, its characteristics and briefs about the configurations of the analog and digital receivers, setting up of the spectro-polarimeter, stage-wise tests performed to characterize it, etc. To demonstrate the instrumental capability, the estimation of the solar coronal magnetic field strength (B vs heliocentric height), using the spectral data obtained with it, is exemplified.

Throughout the above band, the CLPDA has a gain, return loss and polarization cross-talk of ≈ 6.6 dBi, . -10 dB, and . -27 dB, respectively. The design constraints, the procedure to tune its impedance and to minimize its dimension, etc. are elaborated [2]. The analog receiver has a noise figure of ≈ 3 dB and a receiver-noise-temperature (Trcvr) of about 290 K. The digital receiver can sweep and cover the above bandwidth in 4 ms (instantaneous bandwidth of ≈ 1.1 MHz). The spectral data acquired for ten successive sweeps are integrated (for 100 µs) and averaged onboard. The above parameters give a receiver-flux-density (Srcvr) of ≈ 5.3 × 103, and ≈ 5.3 × 105 Jy at 50 and 500 MHz, respectively. The observed spectral data shows a Signal-to-Noise Ratio and Dynamic range of about 30 dB and 40 dB, respectively, at 50 MHz. The average polarization isolation / cross-talk of the CLPD varies from -30 dB to -24 dB over an azimuthal angle of ±45◦ with respect to the reference position angle (0◦). The average degree of circular polarization (DCP) is ≈ 100% at the reference position and found to decrease gradually and reaches ≈ 80% at an azimuthal angle of ±45◦. The variation of the cross-talk and DCP as a function of azimuthal angle were used to have a one to one mapping in order to establish an association between cross-talk and DCP; the latter gives an uncertainty of ≈ 0.2, 2, and 20% in DCP for -30, -20 and -10 dB cross-talk, respectively. The Stokes-I and Stokes-V spectrum of the type-V burst observed on March 30, 2018 with the SP was used to determine the associated magnetic field strength (B) as a function of heliocentric height. It was found that $B(r) \approx 16.8 \pm 0.5\ r^{-3.3}$ G.

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