IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Science, Instruments and Technologies (3B)

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THE HIGH PRECISE BIDIRECTIONAL DOPPLER MEASUREMENT METHOD BASED ON CCSDS PROXIMITY-1 FOR MARS EXPLORATION

Abstract

Mars is the important goal in the exploration of the solar system. The maximum distance between Mars and earth is over 400 million kilometers, which means 22 minutes are needed for the earth station to transmit the telecommand to the spacecrafts on Mars or receive the telemetry from them. In addition, the visible arc between the TT&C station on earth and the Mars probe is also very limited. Therefore, the real time Doppler measurement of the spacecraft on Mars is such a difficulty for earth station and a total automatic high-precision measurement while communicating is needed for orbiters and rovers themselves, which is used to make up for the blind area limitation of the TT&C station on earth. The traditional deep space probes generally do not carry out mutual measurement, or the measurement accuracy is low and the practicability is poor due to the influence of the crystal oscillator jitter, A/D jitter, D/A jitter and other factors. In this paper, the high precise bidirectional Doppler measurement method based on CCSDS proximity-1 for Mars exploration is presented, which avoids the influence of phase noise, group delay, crystal oscillator jitter, A/D jitter, D/A jitter and other factors, adopts high resolution coherent relay mechanism to carry out high precision Doppler measurement while communicating. The method is also used in Chinese first Mars exploration mission (TW-1). By using the conception product with limited FPGA resource, real test shows that the presented method performs well and the Doppler measurement accuracy is better than 0.005Hz.