Automated Ground Station Design for an Amateur LEO Satellite System

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Abstract— This paper describes the RF architecture and automated functioning of the Ground Station of a 2U nano-satellite. The satellite utilizes the UHF band for payload transmission and the VHF band for both satellite uplink as well as beacon downlink. Hence, the station has been set up to have reception capability for the VHF and UHF amateur radio frequency bands. The ground station hardware architecture has been described along with the specification of the components used. The intent behind the automation of the ground station is to enable data collection and satellite tracking during off hours. At the ground station, Doppler shift correction and the control of the Yagi Uda antennas via the rotor control during a satellite pass is automated for continuous data reception. The radio, chip transceiver and rotor control setup are all interfaced to a dedicated PC via a UART line. The PC also hosts third-party software required for reception and decoding. This includes the satellite tracking software, audio recorder and decoder. The specification of the software above and their automation capabilities have been discussed. The ground station functioning was verified by receiving and decoding beacon data from other nanosatellites transmitting on the same amateur radio frequency bands, at heights comparable to the LEO height. The paper also includes the link budget calculations and the subsequent link margin determination. The reception of the beacon and raw data bits from the satellite using a Radio and CC1101 transceiver chip respectively and its subsequent decoding on the computer has been described. It includes all necessary calculations and diagrams.