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DESIGN OF A 40/50 GHZ SATELLITE GROUND STATION FOR FADE MITIGATION EXPERIMENTS

Abstract

ESA's ALPHASAT satellite which shall be launched in 2012 will carry an experimental communications and propagation payload to investigate the Q/V-Band (40/50 GHz) for future commercial exploitation. The ALPHASAT communications payload will provide three spot beams, one centred over Northern Italy, one over Southern Italy and one over Austria. Moving to higher frequencies will be inevitable in the future, since new applications (e.g. 3D-TV, broadband access by satellite) require more bandwidth and the traditional satellite bands (Ku and Ka) may become saturated. At these high frequencies the wave propagation effects have a significant impact on the link budget. The traditional approach of implementing sufficient link margin is not suitable, as it leads to ground station requirements with high EIRP and G/T and consequently high costs. Adaptive coding and modulation is a cost-efficient fade mitigation technique which only requires small margins in the system design since the transmission parameters will be changed in case of fading at the expense of throughput. In 2010 Joanneum Research (Austria) was awarded a contract by European Space Agency to design and implement a ground station for the ALPHASAT Q/V-Band payload and conduct fade mitigation experiments in close collaboration with partners in Italy (Italian Space Agency, Space Engineering, Politecnico di Milano and Università Tor Vergata). The Austrian team will focus its activities on adaptive coding and modulation using DVB-S2 compatible modems in the first phase. At a later stage a self-developed flexible MF-TDMA system with variable modulation and coding will be utilised as well. A novel Ka- and Q-band beacon receiver based on a software-radio platform (also developed by Joanneum Research) will be integrated in the ground station. The beacon measurements will provide fade data for the controller of the adaptive modem/codec.

Since the transponder has a low EIRP, the link is heavily downlink-limited. To achieve the required G/T of the ground station for the combinations of modulation and coding parameters, an antenna size of approx. 3m is required. ALPHASAT will be in an inclined orbit, therefore precise tracking is mandatory. A combination of program and step-track will be implemented. For the high-power amplifier a 50 GHz Klystron has been chosen. It can be operated with considerable output power back-off allowing minimum degradations for modulation schemes such as 16APSK. An LNA with a noise figure of 290 K will be used. The paper describes the ground station design and addresses the planned fade mitigation experiments.