A SWITCHABLE X-BAND TRACKING FEED FOR MULTI-MISSION APPLICATIONS: MILITARY SATCOM, DEEP SPACE NETWORK AND LEO-RECEIVE

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There are three main communication applications at X-band that require monopulse (TE21) tracking. The most common is the Military band (X-Rx/Trk-Mil: 7.25 – 7.75 GHz, X-Tx-Mil: 7.9 – 8.4 GHz), the less common is the deep space network (DSN) band (X-Tx-DSN: 7.145 – 7.235 GHz, X-Rx/Trk-DSN: 8.4 – 8.5 GHz) and one that is becoming more and more important, for receive-only application from low earth orbit (LEO) satellites or drones (X-Rx/Trk-LEO: 7.9 – 8.5 GHz) (Rx: Receive, Tx: Transmit, Trk: Tracking). All these applications use circular polarization and we will assume that both hands of polarization (RHCP & LHCP) are required for each sub-band.

From an operational point of view, if one made the investment of building a large earth station, i.e., a reflector system with an aperture greater than 9m or so and with a suitable antenna pedestal and positioner, having a feed-system that can track and that can be reconfigured remotely through waveguide switches to cater to the three or more missions mentioned above can be a very good investment.

The trick is to design a suitable horn, matched to the chosen antenna optics, that would cover effectively the whole 7.145 – 8.5 GHz frequency band. This optimized horn would need to be connected to a monopulse (TE21) tracking coupler that would work over 7.25 – 8.5 GHz. The tracking coupler would then need to be connected to a circular waveguide transition from a waveguide diameter allowing the propagation of the two orthogonal TE21 modes to a waveguide diameter cut-off to TE21 and allowing the propagation of the two orthogonal TE11 mode. This circular waveguide transition can then be connected to a circular-to-square transition and then to a square-input septum polarizer that provides two ports in circular polarization (RHCP & LHCP) covering the whole 7.145 – 8.5 GHz band. Diplexers would then be needed to separate the required receive and transmit bands. A minimum of two pass-band filters would be required too to prevent the incursion of TX energy into the tracking paths.

The feed network can then be constructed in waveguide using a variety of straights, bends, a 3dB hybrid coupler, two diplexer designs (four diplexers in total), waveguide loads and of course, a number of WR112 waveguide switches that can be controlled remotely.

A possible feed network concept is shown below where, by the suitable use of the waveguide switches, we can reconfigure the feed-system to cater for any of the three applications of interest. The photo of a typical WR112 waveguide switch is also shown. Note that the waveguide switches are set for the Military X-band application in the diagram below.

We will discuss this concept further at the Symposium, including performance details of the various components to try to give an overall performance estimate for the three applications.

We will also simulate the performance of such a feed system on a typical 9m-type earth-station.