ABSTRACT

Satellite constellation technology is to put some satellites in certain orbits so that satellites can communicate with each other. Satellite constellation need additional block that's called Inter-Satellite links (ISL). With the inter-satellite link scheme, each satellite must be able to communicate in all directions. One of the satellites that allows it to work as a constellation namely CubeSat or usually referred as NanoSat. An ISL system with CubeSat constellation moving on LEO orbits (600-1000 km), there is often occur an ionic rotation called faraday rotational effect that can cause Polarization Loss Factor (PLF). Besides, when the satellite is orbiting, it is possible that the satellite will experience tumbling. So that there will be losses due to the depointing of the antenna and it can also causing Polarization Loss Factor (PLF). Therefore, the antenna must produce circular polarization to overcome the PLF. Previous studies have designed circular polarized S-band antenna for inter-satellite link communications, but the antenna separate by 2 and 4 cm with the satellite prototype. In the other study, the antenna use a front-end parasitic technique to generate a higher gain, but it makes the antenna too thick to be implemented. So in this study, the antenna designed will be thin and attached to the satellite prototype.

In this study, the tumbling simulation conducted with several combination of gain and HPBW. In this simulation, there will be two satellites, one as a transmitter and one as a receiver. Satellite receiver will tumbling from 0° to 90°. Then, in order to derive the received power we subtract the received power from link budget calculation with depointing antenna losses, and then compare it with the minimum Received Signal Level (RSL). The antenna use proximity coupled feed with truncated patch technique to produce circular polarization. Electromagnetic Band Gap (EBG) is added to the antenna for suppressing the surface current, so it can generate a larger gain and widen the bandwidth of the antenna. The Electromagnetic Band Gap (EBG) is placed under the antenna by being spread over the substrate. The satellite prototype is a 3U satellite made of steel alloy.

The final result of tumbling simulation shows the trade off between the gain and the HPBW. When the HPBW is 70° the gain minimum is 5 dB, whereas when the HPBW are 80° and 90° the gain minimum is 4 dB. The final design of proposed antenna shows the polarization of antenna is Left Handed Circularly Polarized (LHCP). It was achieved by truncating the edge of the antenna patch. In simulation result, the antenna gain both vertical and horizontal sides are 4.52 dBi and 5.45 dBi which has HPBW $\geq 80°$. It has proven that the EBG element can increase the antenna gain. It was also shown that the antenna has 60.5 MHz and 43.2 MHz effective bandwidth in horizontal side and vertical side respectively.

Keywords: Microstrip Antenna, Inter-Satellite Link (ISL), Half Power Beamwidth (HPBW), Electromagnetic Band Gap (EBG), Tumbling