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SATELLITE-ON-A-RIGID-FLEX PRINTED CIRCUIT BOARD WITH ATTITUDE CONTROL ABILITY

Abstract

As the emerging distributed space mission and system require hundreds to thousands of satellites for real-time, distributed sensing to accomplish the science or engineering objectives, satellite-on-a-printed circuit board (PCBSat) and satellite-on-a-chip (SpaceChip), due to their low cost and mass producibility, are thriving. To maintain its lightness and smallness, existing PCBSat has only very limited attitude control ability. A planar copper coil embedded in the printed circuit board is the most common choice, which generates only one-dimensional magnetic moment. By fixing two extra copper coil on the edge of the PCBSat, three-dimensional magnetic moment can be generated, while the simplicity and lightness of the PCBSat structure would be compromised substantially. Inspired by the conservation of moment of momentum, by employing micro-steppers and flexible printed circuit board (FPCB) technology, we developed a rigid-flex printed circuit board satellite (RFPCBSat) that can adjust its attitude by deformation and reconfiguration. We separate a traditional PCBSat that based on a piece of PCB into several pieces, and connect these separate pieces both physically and electronically by small pieces of FPCB. Micro-steppers are mounted to control the angles between the hard pieces. Meanwhile, the single planar copper coil embedded in the PCBSat is substituted by several planar copper coils embedded in the hard pieces of the RFPCBSat. When the RFPCBSat maintain its planar configuration, all the planar coils are on the same plane, acting like a one-dimensional magnetorquer. When the RFPCBSat deforms by changing the angles between the hard pieces, the normal directions of the planar coils embedded in the hard pieces would change accordingly, thus forming a multi-dimensional magnetorquer. Suppose a FRPCBSat, with a CMOS imager fixed on a hard piece of it, was launched and released into an certain orbit to achieve some image sensing objectives. We can firstly despin and stabilize its attitude by the multi-dimensional magnetorquer, then keep the CMOS imager pointing to the target by precise and subtle reconfiguration and the magnetorquer-generated moment. The RFPCBSat is basically as neat and light as existing PCBSat, because the rigid-flex board design does not complicated the overall design, and the micro-stepper is mounted and soldered just like the other semiconductor chips on board. While compared with existing PCBSat, the attitude control ability of the RFPCBSat is significantly improved.