RAD-HARD HIGH-VOLTAGE BIAS CIRCUITRY FOR A MEMS MICROGYROSCOPE FOR MICRONAVIGATION SYSTEMS

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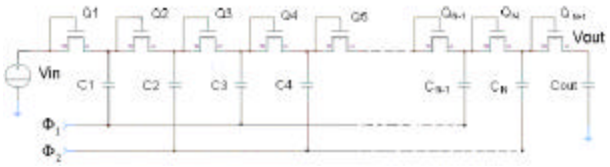
ABSTRACT A project funded by a NASA Research Award (NRA-99-OSS-05-1347) to NanoPower, Incorporated is concerned with developing a single system-on-a-chip (SOAC) solution to replace the current analog board-level electronics. Because of the system requirements for very low noise and for high voltage sensor bias, it is impractical to merely integrate the current analog design onto a single chip using traditional techniques. Thus, a new design is required.

Background Efforts to reduce mass and volume of spacecraft include the miniaturization of on-board electronic systems. One such effort underway at the Jet Propulsion Laboratory in Pasadena, California is the miniaturization of gyroscopes for guidance, navigation and control (GNC). This effort involves two groups: the microelectromechanical (MEMS) sensor group and the power management and distribution (PMAD) group. The MEMS sensor group has been concerned with the development of a MEMS-based microgyroscope along with the associated electronics for a number of years. This device is now available, but the interface electronics consist of a single printed wiring board full of mostly analog commercial-off-the-shelf (COTS) components. The current design requires considerable power (~ 1W), is radiation soft (< 100 Krad-SiO2), provides no compensation for temperature and aging, requires multiple supply voltages, and has an inflexible analog input/output interface.

APPROACH The chip to be designed will consist of a PMAD section, a high voltage gyro bias section, a very low noise sigma delta signal sense and processing section and a digital core. The PMAD section will include a capacitive DC-DC converter that will take the low supply voltage and up convert it to about 30V and 60V. The high voltage bias section will function as a stable low-drift high-voltage level for biasing the gyroscope. This circuit will convert a digital code to a stable high voltage level for biasing the gyroscope. It will utilize low current, SOI CMOS-compatible, high voltage transistors, and get its high voltage from the on chip DC-DC converter of the PMAD circuit. The high voltage transistors suitable for this application will be developed by the University of Idaho. The low-noise sigma delta modulator section will interface with the gyroscope.

WORK DONE A Dickson charge pump circuit with 30V output voltage and 44 mA current drive is implemented in Honeywell's microwave 0.35 mm partially depleted (PD) silicon-on-insulator (SOI) complementary metal-oxide-semiconductor (CMOS) technology (MOI5).



FUTURE WORK The circuit has been fabricated in the Jet Propulsion Laboratories (JPL). The next challenge is to test the chip and make improvement for second run.