Chip-Scale Velocity and Ranging Sensors for Aiding Pedestrian Inertial Navigation

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Pedestrian tracking and navigation systems are useful in in-door, underground or mountainous areas where Global Positioning Systems (GPS) are unavailable. Inertial navigation with accelerometers and gyroscopes is potentially attractive for pedestrian navigation because it does not require prior know-ledge of the environment. However, state-of-the art MEM's accelerometers and gyroscopes do not provide acceptable accuracy; this problem is due to accumulated integration error from uncertain sensor bias. To overcome this issue, an array of RF sensors is used in conjunction with the inertial sensors to enhance accuracy. Two types of RF sensors are utilized – a Terrain Relative Velocity (TRV) sensor that continuous wave (CW) radar to measure the vertical component of velocity; and a Shoe Ranging Sensor (SRS) that uses bidirectional signaling to measure the distance between the two shoes.

Similar to mobile wireless terminals commonly used in communication systems, the RF sensors must be light and consume little power. Nanoscale, low-voltage CMOS technology is appropriate for such sensors. In this project, fully integrated RF transceiver for SRS has been designed in 0.13 µm CMOS technology. It employs low-IF receiver architecture to overcome the problem of DC-offset and 1/f noise in CMOS technology. And it consists of a LNA, down conversion passive mixer, frequency synthesizer including PLL and VCO. For transmitter, SSB mixer and pre power amplifier is designed. The transceiver has been characterized completely in simulation; it consumes 50mW while receiver achieving 35dB conversion gain, 4.45dB DSB noise figure and -1 dBm output power in transmitter. The transceiver was taped out in August 2012 and will be tested for SRS measurement later this year.

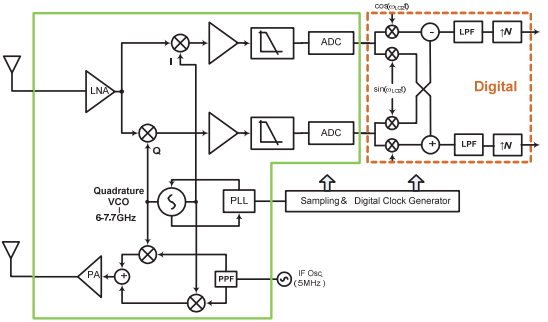

Fig. 1: Transceiver Architecture for SRS system

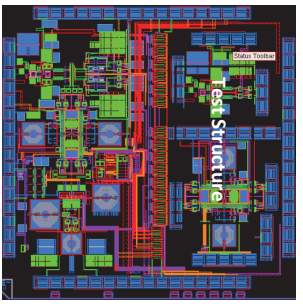

Fig. 2: Layout of SRS Transceiver