CN431 GNSS Receiver Design I: RF Front-End Theory and Design
September 21, 2009, 8:30 am-12:00 pm, CEU: 3.0
GNSS Solutions® Tutorials prior to ION GNSS 2009, September 21-22, 2009
Marriott Savannah Riverfront, Savannah, GA

Instructor: Dr. Sanjeev Gunawardena, Ohio University

Prerequisite: Some knowledge of mathematics, RF circuit design, analog and digital signal processing and GNSS will be useful.

Intended Audience: Design and development engineers, academic researchers, scientists, educators, and managers interested in the area of satellite navigation, particularly with respect to the design and implementation of GNSS receivers, software radio research platforms, or GNSS signal processors.

Notes Provided: Slides presented will be professionally spiral bound, with clear plastic cover, including color to add clarity where needed.

Reference List: A reference list will be provided as part of the note package for completeness and to allow the interested attendee to obtain additional information.

Course Overview: This course is the first of a two-part sequence covering the design and practical implementation of GNSS receivers using the latest developments in radio frequency (RF) and digital signal processing technologies. The material covered will be applicable to a wide range of GNSS user equipment from instrumentation-quality reference receivers through aviation-grade, military, and low-power consumer-grade single chip devices. Part 1 covers the design of single and multiband GNSS RF front-ends starting from the low-noise amplifier (LNA) through to the analog-to-digital converter (ADC). Part 2 covers digital signal processing techniques from sample correlation through range measurement computation, and the implementation of these techniques using hardware, software, or reconfigurable logic (i.e. FPGA) processors. The course material is approached with both the theoretical and practical perspective, using case studies of actual GNSS receivers developed by the instructor as well as an overview of the latest commercially available GNSS chipsets.

Course Content:

- Overview of received GNSS signals: Link budget, signal structure, power spectrum, spreading codes, auto and cross correlation properties, thermal noise, and system noise figure.
- GNSS front-end architectures: Single versus dual conversion, analog versus digital downconversion, direct RF sampling.
- Frequency planning and control: Image frequencies, bandwidth and filter selection, reference clock types and parameters, PLL synthesizers, phase noise, and cost-performance tradeoffs.
- RF/IF components: Parameters important to GNSS signal processing; component selection guidelines for amplifiers, filters, mixers and oscillators.

- Implementation intricacies: Factors affecting the end performance of GNSS receivers such as component-induced multipath, crosstalk, and power supply isolation.
- Sampling subsystem: ADC specifications, impact of sampling resolution and jitter, automatic gain control, dynamic range considerations.
- GNSS front-end design techniques and case studies
    - Modular design using connectorized components
    - PCB-level design using discrete RF components
    - Commercial GNSS MMICs for portable electronics

Course Outcomes: At the completion of this course, the attendee should have a solid understanding of the fundamentals of GNSS receiver RF front-end design including the many options and sources available for implementing your own GNSS receiver prototype or research testbed. Part II of this two-part sequence covers GNSS signal processing techniques and platforms, and is highly recommended for those desiring to get a well-rounded primer on GNSS receiver design.