Navigation Signal Generation Module

RUAG Space provides the core module of the Navigation Signal Generation Unit (NSGU), which is the main subsystem of the Galileo navigation satellite payload.

The NSGU generates the signal that enables users on the ground to determine their position and to benefit from information that is distributed by those satellites. The NSGU formats navigation data that are received via the satellite’s mission receiver and modulates them on the spread spectrum coded navigation signals. Further, it establishes a time-base by processing data from the on-board clocks, which is added to the message stream.

The analogue output signals from the NSGU are passed to the L-band up-converter and power amplifier.

The NSGU comprises a microprocessor control module, a power converter and the NSG module.

NSG Module:

The module allows to generate the three navigation signals L1, E6 and E5 simultaneously.

It is based on a mixed digital and analog board, which performs all high-speed signal generation and processing tasks of the NSGU.

The signal processing task is handled by three identical ASICs called GASIG. Both the board and the GASIG ASIC were designed and tested by RUAG Space. The generated IQ E5 baseband signals are upconverted to an intermediate frequency of 122.76 MHz by use of a quadrature upconverter located on the NSG module.
Features

NSG Module Architecture:

- L1, E6 and E5 signal generation by GASIG
- Interface to NSGU computer (SpaceWire)
- Digital to analog converters working at 122.76 MHz clock frequency, including reconstruction filters
- E5 quadrature upconverter to 122.76 MHz
- Public Regulated Service (PRS) interface
- Flexible modulation:
  - Interplex (CASIM) with sine and cosine binary offset carrier (BCO)
  - Multiplexed BOC (MBOC), both Composite (CBOC) and Time-multiplexed (TMBOC)
  - Alternate BOC (AltBOC)

Board Interfaces:

- L1 real IF signal analog output
- E6 real IF signal analog output
- E5 real IF signal analog output
- SpaceWire interface
- Clock interface at 122.76 MHz
- Public Regulated Service interface (PRS I/F)
- 1 PPS output

ASIC Architecture:

- Processor interface
- Navigation data buffer
- Sub channel data / secondary code data formatter
- Memory-based code generator
- Code encryption for Commercial Service
- Test signal generator
- Spreader signal generators with digital filters, sub- channel up-converter and NCO, IF up-converter
- Public Regulated Service interface
- Timing generator
- Gain DAC control

Physical / environment:

- Plug-in module
- Size: 261 mm * 227 mm * 25 mm incl. frame
- Weight: < 1300 g incl. frame
- Operating temperature: -20° C to +70° C
- Radiation: cumulative dose >100 kRad (Si)

Programs

The described NSG Module is the main constituent of the NSGU (Navigation Signal Generation Unit) which was designed by a team of RUAG Space AB in Sweden, RUAG Space GmbH in Austria and Astrium Germany. It is accommodated on two satellites of the Galileo In-Orbit Validation Phase.

The module is the result of comprehensive pre-development work, that had started in the year 1999. A pre-cursor version of the above described NSG module was launched on-board of the GIOVE B (Galileo In-Orbit Validation Experiment B) Satellite in 2008.

This satellite allowed to successfully transmit the multiplexed BOC (MBOC) signal for the first time in the history of GNSS (Global Navigation Satellite System).