

Low Cost, Compact GNSS Modules for Atmospheric Probing

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Abstract

Global Navigation Satellite System (GNSS) is currently used for various types of applications including studies of atmosphere and space weather. Monitoring the strength of received GNSS signal is a standard method for such atmospheric research. Special purpose, costly GNSS receivers are globally used for such application by the researchers. Very recently multi-constellation, cost effective, compact and low power consuming GNSS modules became readily available in the market. Few latest modules are dual-frequency enabled providing much higher precision in position and time. These modules may be operated in stand-alone as well as in Real Time Kinematic (RTK) modes, can provide modest solution and timing accuracies and naturally are being popular for various positioning and timing applications. These modules can also be attached to Android based handheld devices for data recording using suitable “Apps” running on the handheld without a computer. These modules provide real time data both in ASCII NMEA format and in binary raw format, that can be used by various freely available GNSS processing tools for post processing. These modules can easily be integrated with compact, single board microcomputers running with own Operating System having on-board memory to store data. Codes can be written in these microcomputers to receive the NMEA data stream over the GPIO or USB ports for processing the same according to the user needs and to record it in the on-board memory, if necessary. The NMEA data stream provides PVT information and satellite related parameters including the received signal strengths of the tracked GNSS satellites in terms of Carrier to Noise ratio (C/N_0). Therefore, the setup can be used for study of the atmosphere through monitoring the C/N_0 values. The customized code can monitor the instantaneous C/N_0 values and report any out-of-range values through visual or audio alerts using the GPIO ports of the microcomputer or can create a text file containing the information about the incidence with appropriate time stamp. The alert may be generated based on the C/N_0 values or based on derived other related terms calculated in the microcomputer or through a combination thereof. The saved data from the on-board memory can be used for post processing and validation of the instantaneous observations. The collected data may also be sent to a central server using attached Cellular modems integrated with the microcomputer’s IO pins or using a cellular dongle over the USB port. The whole setup consisting of the GNSS module, antenna, microcomputer and the peripherals may run on small battery packs, are compact and therefore enhances the ease and autonomy of data collection. Cost effectiveness of the whole system enhances the scope of simultaneous use of similar multiple number of sensors distributed over a geographical region for data redundancy. Use of multi-GNSS may help in monitoring the scenario simultaneously using large number of signals from all directions. With the operation of regional navigation systems like NavIC, QZSS and availability of similar compact RNSS-enabled modules enhances the scope of monitoring signals transmitted from GEO or GSO orbits along with the MEO-originated GNSS signals for probing the atmosphere up to much higher heights. With proper calibration technique for these modules, such compact, cost-effective and power efficient modules may be efficiently used for atmospheric research.