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Development of a radiofrequency signal generator for ionosonde radar transmitter using red pitaya

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The Jicamarca Radio Observatory (JRO) is a facility of Instituto Geofísico del Perú (IGP), dedicated to monitor the upper atmosphere with different instruments like radars, GNSS receivers, magnetometers, among others. Ionosondes is a type of HF radar that uses multiple frequencies to examine the ionosphere and could provide estimates of electron density. The purpose of this work is to develop a low-cost radiofrequency signal generator for the ionosonde radar transmitter based on the SDR Red Pitaya Signal Lab 250-12. The generator consists of an SoC FPGA Zynq-7020 with a sampling frequency of 250 Msps, and it can transmit modulated signals with a frequency sweep ranging from 1 MHz to 60 MHz, providing the possibility of using it with other CW radars. For the design, the Vivado development environment from Xilinx-AMD was used. The hardware synthesis was based on the VHDL hardware description language, using a behavioral description style for the modules, such as the SPI controller, register map, numerically controlled oscillator (NCO), OOK modulator, multiplexer, synchronization module with a 10 MHz GPS clock input, and trigger for signal transmission initiation. Subsequently, all the mentioned modules and IP Core Clocking Wizard were integrated using the structural description style in the Vivado software. Additionally, an embedded system was used for register writing through the SPI protocol. The initial tests were carried out at the Vertical Incidence Pulsed Ionospheric Radar (VIPIR) located at the IGP-JRO, where pulsed signals were successfully transmitted using the radiofrequency signal generator. Ionograms were obtained using both the VIPIR receiver and the Ionospheric Echoes Receiver (IER) based on USPR.