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CENTRO DI COMPETENZA DEL DIPARTIMENTO DELLA PROTEZIONE CIVILE - PRESIDENZA DEL CONSIGLIO DEI MINISTRI

CNR _ INOA

INFRASOUND ARRAY SYSTEM TO MONITOR VOLCANIC ACTIVITY

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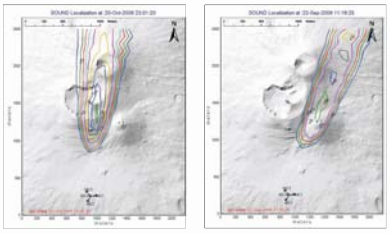
A new infrasound sensors array system, based on optical fibre transmission, has been realized to monitor the explosive activity of the Etna volcano. The system is composed by an 8 channels receiver central station, recording data from 4 low power sensor nodes, measuring the following parameters:

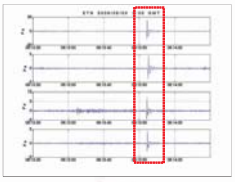
1. Infrasound signal (16 bits) 2. Temperature (1°C accuracy) 3. Voltage of battery (8 bits)

The Etna infrasound network has a "star" configuration, organized in 4 stations, working like "antennas" to provide in real-time the propagation azimuth of the sonic beam. According to the geometry of the array it's possible to resolve the infrasound source position by grid searching algorithm calculating in real-time the cross-correlation between the single station. The infrasound signal, acquired by a microphone, is filtered by an active, low noise, 5 order, 20Hz low pass filter, then it is acquired by a 16 bit ADC at a rate of 50 samples/sec. The user can set an amplification factor of 0,1/0,5/1/10.



Array position and localization of the source in two different days

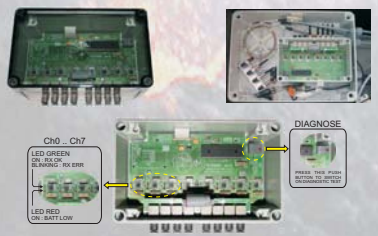
The infrasound monitoring system includes a full diagnostic functionality that performs an exhaustive test without use of other device: this is a very important function because the array is installed on the volcano flanks at 3000 meters altitude. The diagnostic system shows the integrity of the optical fibre communication line, and the battery charge status of each connected node. One of the new feature of this system is the low power consumption of the single node which allows to collect data continuously for one year at least, using only a 60 Ah gel battery as power supply. The sensor nodes transmit data to the receiver central station by means of an optical fibre, assuring the best SNR ratio and the network integrity against atmospheric agents, as lightnings. Thanks to this solution each node is also electrically insulated from the others, guaranteeing the correct system working even if one or more sensor nodes break down.



Example of infrasonic registration

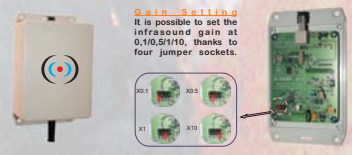
All the data collected by the receiver are sent via radio modem link to the acquisition centre in Nicolosi, 16 km away from the volcano summit. Finally the information are forwarded in the Web to the Department of Earth Science of the University of Florence, where are processed in real-time, in order to detect overpressure and origin site of the infrasonic events. Infrasonic array are quite important when a daily report about the volcano activity, is needed to Civil Defence purposes. Moreover, infrasonic array are now always more often used by the World Meteorological organization and by the International Civil Aviation Organization as the most appropriate monitoring tool to promply detect volcanic eruption worl wide.

The 8 channel data receiver



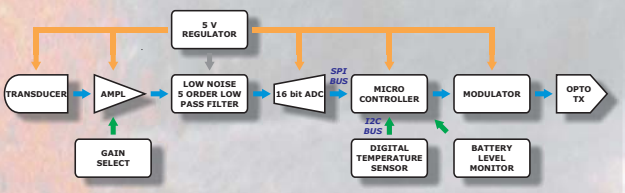
CHANNELS : 8
POWER SUPPLY: 7.0Volt ... 15.0Volt
INPUT DATA: Optical ST Connector
DATA OUT: 19200 Baud
DATA FREQ: 50 Samples/Sec
DIAGNOSTICS: Optical Fibre Integrity
DIAGNOSTICS: Accumulator Charge Status

The infrasound sensor node



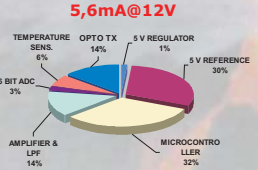
POWER SUPPLY: 6V - 15V
CURRENT: 5.6mA @ 12V
SAMPLING RATE: 150Hz
INFRASOUND SNR: 84.3dB
LPF CUTOFF FREQ: 20Hz
LPF ORDER: 5
TEMPERATURE ACCURACY: 1°C
VOLTAGE SUPPLY ACCURACY: 59 mV
OUTPUT DATA: OPTICAL ST CONN.

Sensor node functional diagram



This functional diagram shows the main blocks of the infrasound sensor node, the design aims to obtain the best S/N ratio with the lower consumption of energy (5,6mA@12V). The chart points out the energy consumption of each block.

5,6mA@12V



Other typical Infrasound Applications:

- **Volcanic Activity: volcanoes emit powerful pulses of infrasonic energy near the moment of eruption**
- **Meteor detector: meteors generate infrasound weaves during their entry in the Earth's atmosphere**
- **Avalanche detection: before an avalanche happens the is an infrasound emission, most likely this comes from deep down movements in the snow**
- **Nuclear explosion: the nuclear tests generate intense infrasonic weaves, it's possible to reveal these explosions both under the water and under the ground**
- **Aircrafts flying and missiles launch: all these events generate infrasound weaves that can be revealed at long distances, giving useful information about them**

INFRASONITUS