ON APPLICATION OF A PULSE METHOD IN DETECTING THE LIVING OBJECTS

S. Jefremov*, B. Levitas**

There are demonstrated pulse method's possibilities in living object's detection by system, based on 30 GHz sampling oscilloscope. It is shown, that biological objects can be observed even in unmoved and unbreathed condition due to involuntary movements and palpation of heart.

In the last years number of researches, directed on the use of short-term (picosecond) videopulses for resolving radiolocation problems, has increased. The application of such pulses provides high resolution, allows to measure the characteristics of objects in a wide frequency range, that it is important when determinating type of object and detecting objects with a small effective reflecting surface.

The conducted researches solve two problems: direct - observation and registration of scattered signals, and return - identification of objects on a scattered by them field. Not having statistical data on the scattering characteristics of biological objects and without development of the appropriate algorithms of restoration of properties and form of objects, we have carried out preliminary researches, including test measurements of the reflection characteristics of the man as of scattering object.

The block diagram of system for investigation of scattering in time domain and demonstration of the possibilities of detection living objects contains (see Fig.1): Source of pulses of radiation - pulse generator (PG) with duration 30 ps and amplitude 25 V, transmitting and receiving antenna and reception device - sampling oscilloscope (SO), interfaced with the personal computer (PC) controlling system operation and signal processing. The devices are placed on the mobile carriage.

As receiving and transmitting antennas were used horn measuring antennas, overlapping a continuous range of frequencies 1,0 - 18 GHz.

* Sergej Jefremov, Geozondas Ltd., Vilnius, Lithuanian Republic
** Dr. Borys Levitas, Geozondas Ltd., Vilnius, Lithuanian Republic

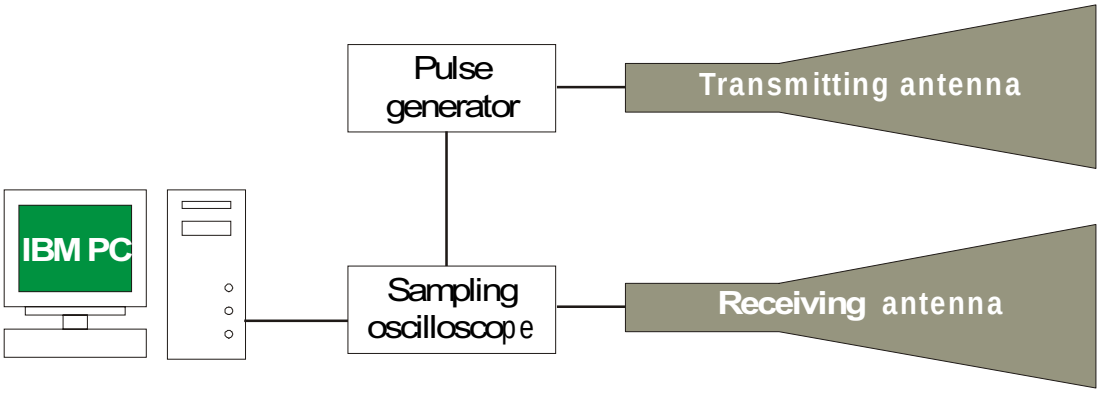

Fig.1 Block diagram of system for investigation using picosecond pulses

Interfaced with PC the sampling oscilloscope represents the SD-200 Digital Sampling Precision Measurement System of the Geozondas company with a frequency range 0 - 30 GHz in two measuring channels, allowing to make precise measurement of parameters of signals with accuracy less than 1 %, and distinguished by high sensitivity and high dynamic range of measurements due to low noise (less than 3 mV rms without accumulation) and also wide set of mathematical processings both «living» and stored signals. The software includes various algorithms of signals filtering to isolate signal from noise, overlapping frequency and temporary windows to select optimum of the necessary information about objects under test, representation of the information in frequency domain using Fourier transform algorithms.

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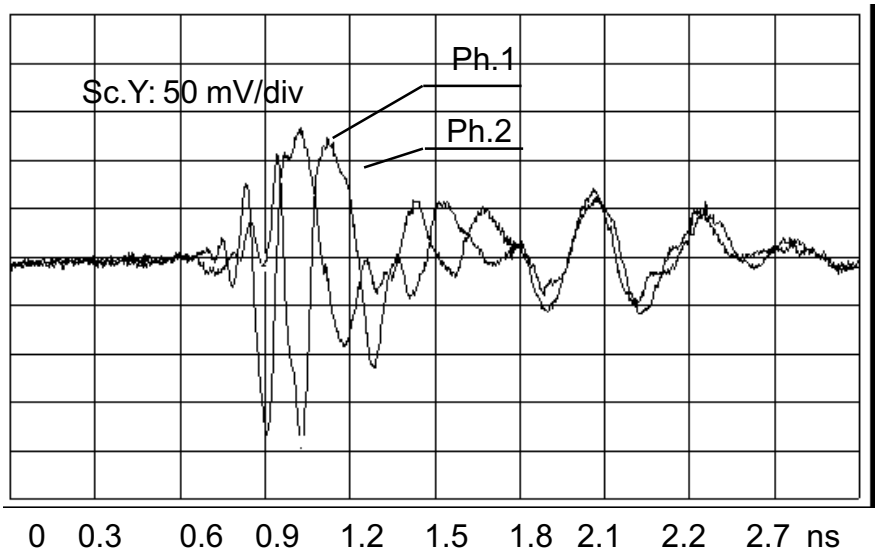

Fig.2. Freely respiring man's responses

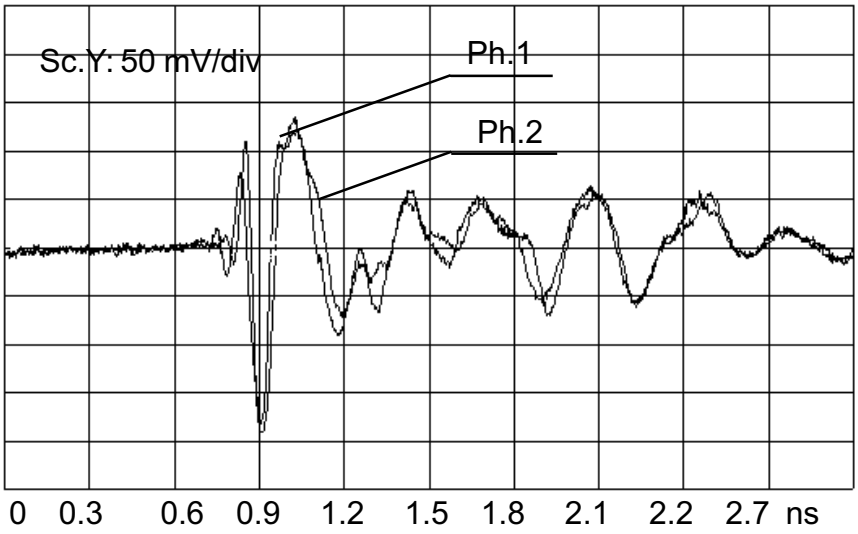

Fig.3. Maximum "frozen" man's responses

As an example the results of inspection of system response to a man in various condition are submitted: on fig. 2 the temporary responses from freely respiring man «free man" in two phases - in a phase breath (phase 1) and in a phase exhalation (phase 2), on fig. 3 - change in the form of the maximum «frozen man" response are shown.

On fig. 4 spectra of given signals difference are given. We can see, that even in still conditions it is impossible to disguise own resonant frequencies of a body, there is only the widening of frequency spectrum to higher frequency domain.

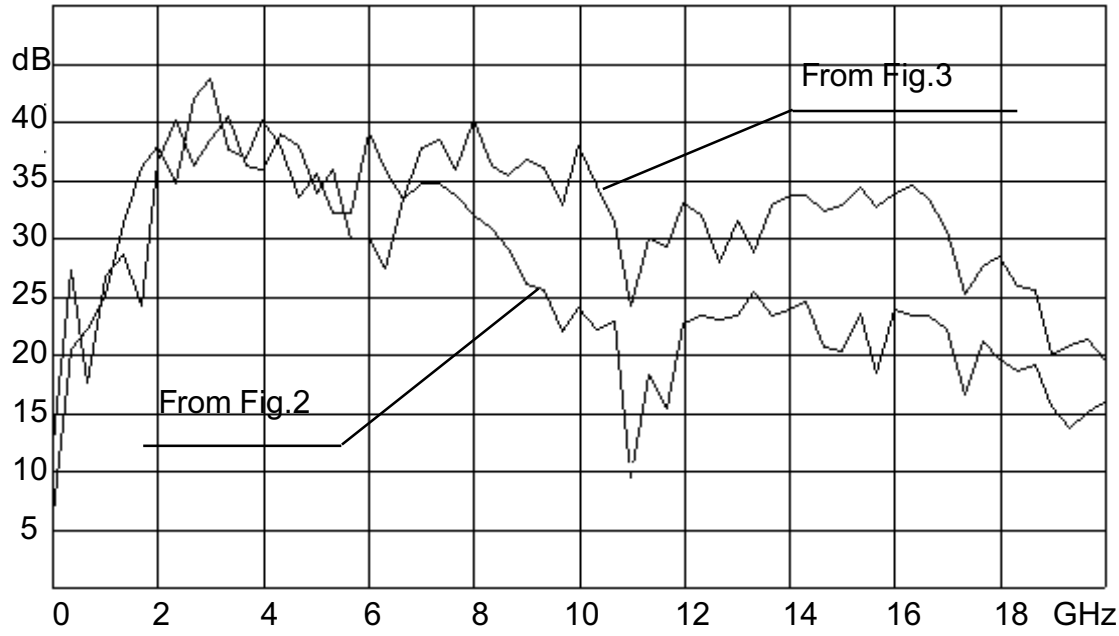

Fig.4. Spectrum of signals in Fig.2-3

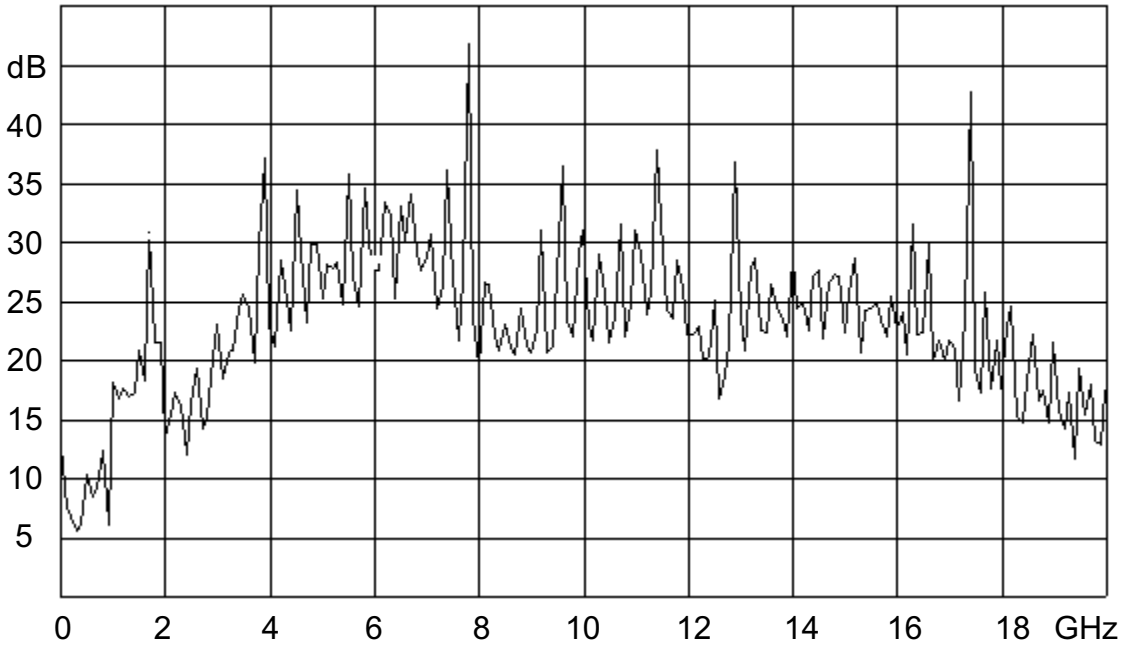

Fig.5. Spectrum of absorption coefficient

For research of masking properties of the refuges the additional investigations of absorbing properties of the given building materials are required. For an example we show frequency dependence of absorption coefficient of a signal passing twice a brick wall with thickness 25 cm (Fig.5). We see, that the absorption in the frequency range of 1-17 GHz is in the field of 15-20 dB, that coincides to the measurement system dynamic

range. The dynamic range is increased when applying signal filtration methods available in the software and also can be extended by additional amplifiers.

Conclusions:

1. An experimental system to investigate the detection of the living objects behind a wall is developed.
2. Signals reflected from man are registered and displayed.
3. The reflection from biological objects is characterized by signal amplitude and phase changes, observed in real of time (in result of breath, palpation of heart and other physiological functions). The additional information on properties of object can be received due to presence of own resonant frequencies typical for each type of object.
4. Even if the living object to not breathe and not move, there is a jitter of signal due to involuntary movements and palpation of heart*.
5. There is a possibility to create a portable radar for detection of living objects behind a wall. For this purpose it is necessary:

5.1. To carry out detailed research of reflecting properties of a human body in the frequency range 1-18 GHz.

5.2. To develop algorithm of identification of living objects behind a wall by scanning (movement of the radar along a wall).

5.3. To develop portable radar, in which in comparison with the given system the following characteristics are improved:

- sampling frequency is increased from 100 kHz up to 1MHz;
- dynamic range is increased to 20-40 dB due to the use of the amplifiers in a given frequency range;
- dimensions and mass of the device are decreased due to the use of built-in computer and signal processor.

6. The Geozondas company has a large experience in the given area. In particular our compact georadar GPR has built - in algorithm for identification of objects according to the results of scanning. The device is used for videopulse location of subsurfaced objects.

* Note: When there are continuous metal shields in walls the objects will not be detected.