THE MEASURING POST OF ACOUSTIC SENSORS

M.Bogdan* , S.Fita**

Introduction

The research works connected with acoustic sensors in measurements of distance has a rich, about 30 years old, bibliography [1,2]. They concentrate on calculation of interdependencies among: the pressure in the feed system, mass and the speed of air flux, pitch and volume of sound which acoustic sensor generates and the distance from a measuring object. Advantages of this type of sensors are widely known. They require low working pressure (about 100 mm H_2O) and not large mass of flow. They are characteristic of a high precision and a considerable speed of measurement. Often that function of the characterization of the sensor, which is dependent on conditions of the measurement, is considered to be a disadvantage. When parameters of the pressure and speed of the flow are constant, the value of the frequency depends on a temperature, density of the air and contents of the water vapour. The frequency, which is generated, is a function of the distance from the measuring object. A resonance chamber is delimited by geometry of the sensor together with variable 'measuring space'. It depends on the location of the sensor in relation to the measuring surface, its shape and quality of mechanical tooling. The construction of the sensors allows to work in an acoustic band and in ultrasonic range, and selection of the range depends on measuring magnitudes.

It's possible to fix measuring properties of the sensor basing only on elementary formulas, which define resonance frequency on the ground of the shape and geometrical dimensions. However, they don't allow calculating harmonic components, which can serve to estimate the quality of the sensor. Therefore, there is a necessity of building the measuring post, which allows calculating interdependencies regarding digital signal transformation (DSP). The paper presents the description and measuring possibilities of the post for calculation of the select parameters of the sensors in acoustic band.

Choice of the solution

A standard measuring post consists of a feeder, a microphone, an analogy signal amplifier and a measurement system of the effective value and frequency (Fig.1). Owing to that it is possible to calculate the characterisation of the amplitude value and frequency as a function of a distance from a measuring surface. That solution does not permit to calculate harmonic frequencies, which determine the quality of the sensor.

Development, we achieved in technology of digital elements VLSI production, allows to build a measuring post basing on semi-conductor sensors adapted to co-operation with signal processors. Combining a computer with the post allows for visualisation of the measurement results and helps to assess constructional parameters.

* Institute of Engineering Cybernetics Wroclaw University of Technology,
ul.Janiszewskiego 11-17, 50-370 Wrocław, Poland, Tel.320-27-52
E-mail: mbogdan@ict.pwr.wroc.pl

** Institute of Mechanical Engineering and Automation, Wroclaw University of Technology
ul.Łukasiewicza 3/5, 50-371 Wrocław, Poland, Tel.320-27-28
E-mail: fita@itma.pwr.wroc.pl

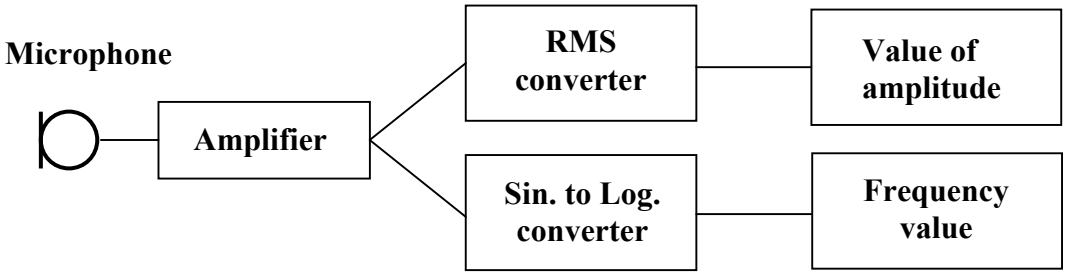


Fig.1. The structure of the analogy measurement

The structure of the measuring system

The structure of the measuring system is shown in the picture above (Fig.2). Systems in it are:

- Feed module
- Measurement and calculation
- Graphical representation

A feed module comprises the stabilisation of the flow and the air pressure. The sensor of the pressure is an integrated circuit MPX (Motorola's firm) stabilized by temperature. A digital thermometer DS1820 made by Dallas firm, and equipped with serial interface 'one wire' measures the temperature of the air. These sensors allow verifying constancy of the pressure and the temperature during the measurement.

The measurement and calculation system is composed of an universal module of the signal processor EVM62005DSP by Motorola. Here, there is the integrated circuit CODEC CS4215 (Crystal firm). It contains 16-bits converter sigma-delta A/C and C/A with a frequency till 50 kHz and the digital controlled amplifier of the acoustic signal (20dB). DSP controls CODEC accepts data and settles amplification of value by synchronous serial interface (SSI). Analogy data are converted into discrete form supported by Fourier's transformation and sent to computer by RS232. The main computer performs a function of the control of the experiment, final transformation and visualization of the results. It initiates DSP work, accepts and graduates data according to a logarithmic scale and uses Excel programme for their visualisation.

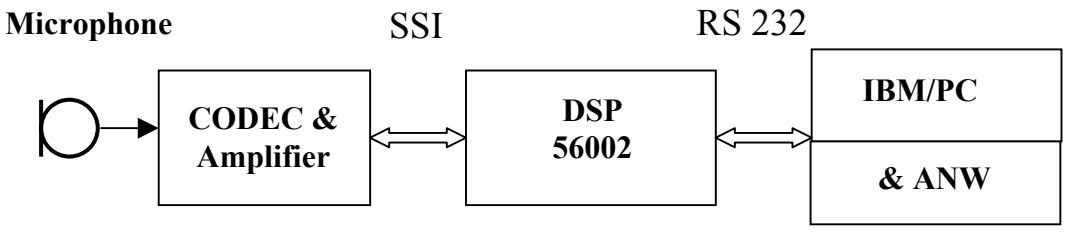


Fig.2. The measurement structure and digital conversion

Function of the programme

ANW is a programme written in C++ language. It serves to communicate with the processor DSP56002 and to convert and accumulate measuring data initially. An effort has

been made to gain effect of standardisation and possible facilities of the service. Only 3 buttons control active windows: Px, Log, L++.

- Px – start/stop continuous of the measuring data
- Log – definition of the file for recording measuring data
- L++ - adding measuring data to previously defined file.

They permit to enter series of measuring data, logarithmic graduation of the harmonic components and transferring the results to the user's file. Next data are sent to Excel programme, where the way of the result illustration can be selected. Measuring possibilities of the post for the characterization delimitation of the acoustic sensors are shown in the pictures below. The constant value of the air pressure is equal 0.1. The distance from measuring surface changes from 0.1 mm to 2 mm (Fig.4a) and from 2 mm to 3 mm (Fig.4b). Fig.5 shows the situation where the measurement surface touches the sensor at 15^0 of the angle. The main window of programme is shown bellow (Fig.3).

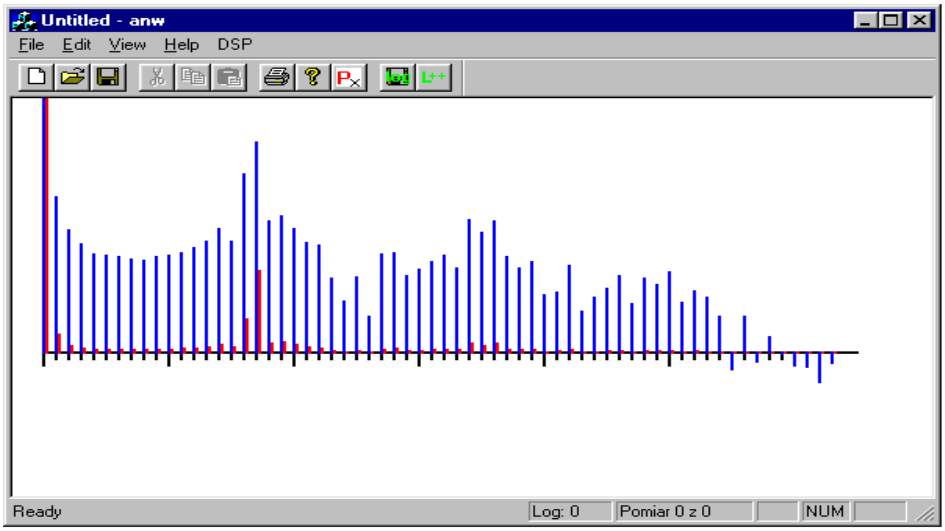
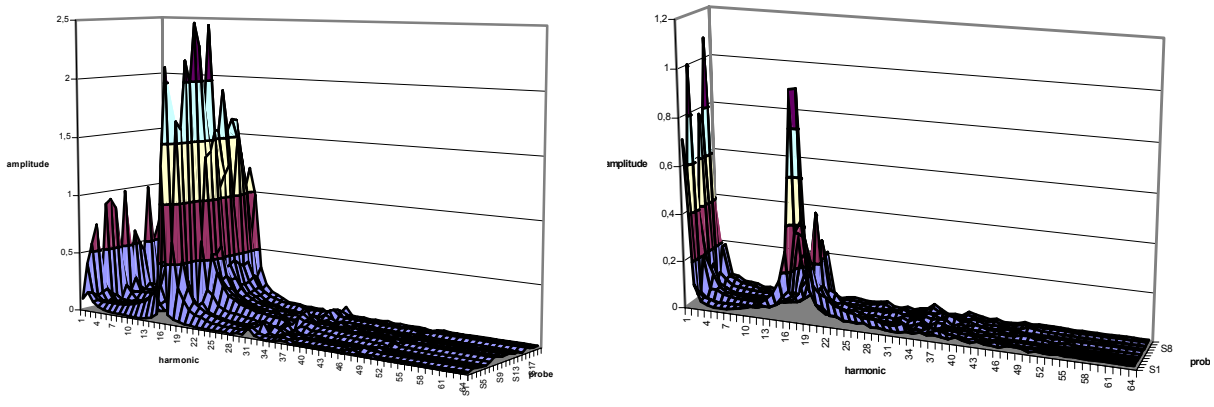


Fig.3. The window of the programme



a) b)

Fig.4 Twenty measurement series of the distance (a) from 0.1 mm to 2.0 mm, and ten series of the distance (b) from 2.0 mm to 3.0 mm.

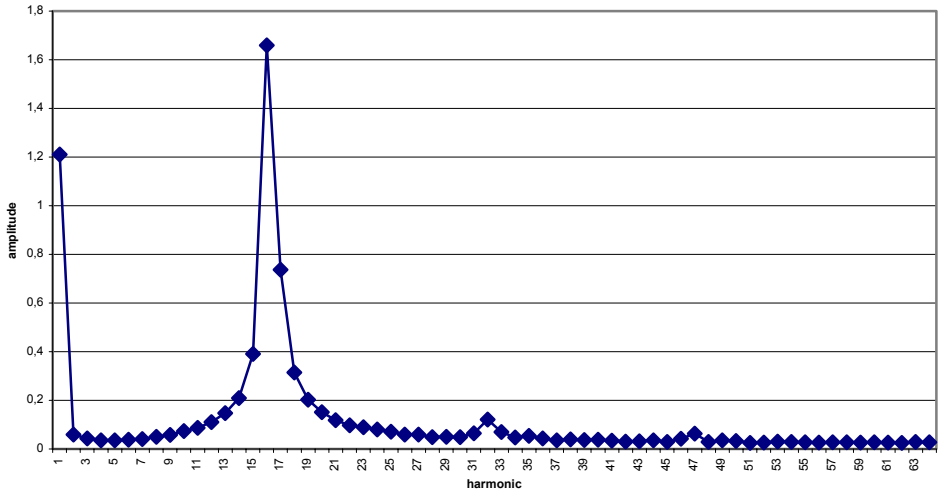


Fig.5. The sensor's angle 15° to the measurement surface

Summary

The character of the post described in the paper and used for research on acoustic sensors properties is universal. Measurement of the pressure and air temperature allows calculating the characterisation of the sensor in different conditions. Somebody can wonder if the calculation of Fourier transformation by means of 24-bits DSP works in a situation when, for example, Matlab system is attainable. It seems that the use of universal EVM to convert signals with DSP together with CODEC's 20dB amplifier is well founded. Moreover, communication possibilities of the system, such as application of Excel programme to visualisation and data storage, are not devoid of significance.

Literature

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