# ABSTRACTS

of the scientific papers of
Chief Assist. Prof. Eng. Hristo Zhivomirov Karaivanov, Ph.D.,
for participation in competition for
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Professional field: 5.2. Electrical Engineering, Electronics, Control Engineering
Discipline: Electrical Measurements

**Category B.3.** Habilitation work

| № | Bibliography |
|---|---|
| 1. | H. Zhivomirov. The Spectral Analysis and Synthesis in the Modern Measurement Practice. Varna, Color Print, 2019. ISBN: 978-954-760-489-6. |

**Category G.7.** Scientific publications indexed by worldwide referencing databases

| № | Bibliography |
|---|---|
| 1. | H. Zhivomirov. On the Development of STFT-analysis and ISTFT-synthesis Routines and their Practical Implementation. TEM Journal, ISSN: 2217-8309, DOI: 10.18421/TEM81-07, Vol. 8, No. 1, pp. 56-64, Feb. 2019. |
| 2. | H. Zhivomirov. A Method for Colored Noise Generation. Romanian Journal of Acoustics and Vibration, ISSN: 1584-7284, Vol. XV, No. 1, pp. 14-19, 2018. |
| 3. | H. Zhivomirov. A Novel Visual Representation of the Signals in the Time-Frequency Domain. The Scientific Bulletin, Series C: Electrical Engineering and Computer Science, ISSN: 2286-3540, Vol. 80, Issue 3, pp. 75-84, 2018. |
| 4. | H. Zhivomirov, N. Kostov. Power Parameters and Efficiency of Class B Audio Amplifiers in Real-World Scenario. Radioengineering, ISSN: 1805-9600, DOI: 10.13164/re.2017.0258, Vol. 26, No. 1, pp. 258-262, Apr. 2017. |
| 5. | I. Iliev, H. Zhivomirov. On the Spatial Characteristics of a Circular Piston. Romanian Journal of Acoustics and Vibration, ISSN: 1584-7284, Vol. XII, No. 1, pp. 29-34, 2015. |

**Category G.8.** scientific publications in non-indexed journals or in edited collective proceedings

| № | Bibliography |
|---|---|
| 1. | H. Zhivomirov, I. Iliev. Radiation Pattern Measurement with Matlab Implementation. Journal of the Technical University of Gabrovo, ISSN: 1310-6686, Vol. 52, pp. 73-76, 2016. |
| 2. | H. Zhivomirov, I. Iliev. Impedance Frequency Response Measurement with Matlab Implementation. Journal of the Technical University of Gabrovo, ISSN: 1310-6686, Vol. 52, pp. 61-65, 2016. |
| 3. | H. Zhivomirov, I. Iliev. Generation of Measurement Signals with Matlab Implementation. Acoustics, ISSN: 1312-4897, Vol. 15, pp. 87-90, 2013. |
| 4. | H. Zhivomirov, G. Dimitrov. Some Characteristics of the High-pass RC-networks in the Differential Amplifiers. Acoustics, ISSN: 1312-4897, Vol. 14, pp. 82-88, 2012. |
| 5. | H. Zhivomirov. Amplifiers Noise Measurement with Matlab Implementation. Third International Scientific Congress Proceedings, ISBN: 978-954-20-0551-3, Vol. 2, pp. 32-37, 2012. |
| 6. | H. Zhivomirov. Design of an automatic gain control system for Wien bridge oscillator. Acoustics, ISSN: 1312-4897, Vol. 12, pp. 27-32, 2010. |

**[B.3.1] H. Zhivomirov. The Spectral Analysis and Synthesis in the Modern Measurement Practice. Varna, Color Print, 2019. ISBN: 978-954-760-489-6.**

The book is a monograph dedicated to the application of the digital signal processing in the modern measurement theory and practice, with a particular focus on the spectral analysis and synthesis.

A critical review of the current state of the measurement practice has been made, and a new paradigm in the theoretical and practical aspects of the measurements has been presented.

A new insight on the theory of the spectral analysis and synthesis is proposed, and new methods and algorithms for measuring of some basic quantities are proposed, with their application. An attention is paid to the physical aspects of the processes and their practical utility.

The statement is supported with an intelligible mathematical apparatus, rich graphical and tabular materials, computer simulations in the Matlab® software environment and real-world measurements.

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**[G.7.1] H. Zhivomirov. On the Development of STFT-analysis and ISTFT-synthesis Routines and their Practical Implementation. TEM Journal, ISSN: 2217-8309, DOI: 10.18421/TEM81-07, Vol. 8, No. 1, pp. 56-64, Feb. 2019.**

This work introduces the development of two software routines for Short-Time Fourier Transform (STFT) and Inverse Short-Time Fourier Transform (ISTFT) along with know-how about their practical implementation. The proposed algorithms and the corresponding novel Matlab® functions form a conjugated analysis-synthesis pair and assist the time-frequency analysis, processing, resynthesis and visualization of real-world non-stationary signals.

The STFT and ISTFT algorithms are implemented and tested in the Matlab® and accompanied with a software product named “*OLAExam*” that assists the proper choice of the analysis/synthesis windows' length and hop size, in order to achieve synergy compliance and thus perfect reconstruction.

The statement is supported with comprehensive notes and recommendations concerning the applied aspects of the functions usage, along with an original approach for defeating of the edges' amplitude attenuation and length reduction of the resynthesized signal.

Examples of analysis, spectral modification and resynthesis of non-stationary signals are provided that confirm the consistency of the algorithms and routines, along with example for the outperformance of the proposed analysis function in comparison with the corresponding in-built Matlab® function *spectrogram*.

The developed software routines are a new impact in the TFD processing practice. The paper also assists the better understanding of the STFT and ISTFT concepts and their practical application and therefore has high methodological value. The corresponding Matlab®-functions are accessible at:

https://www.mathworks.com/matlabcentral/fileexchange/45197-short-time-fourier-transform-stft-with-matlab

https://www.mathworks.com/matlabcentral/fileexchange/45577-inverse-short-time-fourier-transform-istft-with-matlab

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**[G.7.2] H. Zhivomirov. A Method for Colored Noise Generation. Romanian Journal of Acoustics and Vibration, ISSN: 1584-7284, Vol. XV, No. 1, pp. 14-19, 2018.**

In the paper a method for colored noise generation with arbitrary user-defined spectral slope is presented. The procedure is based on generation of a white noise time sequence, its spectral processing in the frequency domain and translation of the newly obtained spectrum back in the time domain. Every spectral line is weighted proportionally to its spectral number (i.e., frequency), so the overall ASD slope is proportional to the frequency by the law $f^{\alpha/2}$ and the PSD slope – by $f^{\alpha}$. Also, it is possible to control the average and RMS values of the generated colored noise sequence.

The method is tested in the Matlab® environment and the results clearly indicate its consistence. It is simple and quick and can be used to generate noise over frequency band of arbitrary size with arbitrary values of the PSD slope and ability of real-time operation.

The proposed method is a new impact in the noise generation practice. The possible applications of the method including but are not limited to audio, acoustics, vibration engineering, microelectronics, neuroscience, econometrics, in measurements and simulation applications, including real-time ones. The algorithm is implemented in the Matlab® software environment as Matlab®-functions and accessible at:

https://www.mathworks.com/matlabcentral/fileexchange/42919-pink--red--blue-and-violet-noise-generation-with-matlab-implementation

https://www.mathworks.com/matlabcentral/fileexchange/48628-arbitrary-spectral-slope-noise-generation-with-matlab-implementation

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**[G.7.3] H. Zhivomirov. A Novel Visual Representation of the Signals in the Time-Frequency Domain. The Scientific Bulletin, Series C: Electrical Engineering and Computer Science, ISSN: 2286-3540, Vol. 80, Issue 3, pp. 75-84, 2018.**

The work presented in this paper describes a novel way for visual representation of the results obtained by Short-Time Fourier Transform (STFT) on a given signal in the time-frequency domain (TFD), named “iris-spectrogram” (irisgram) for its similarity to a human iris – a circular plot where the time increases azimuthally (circumferentially) clockwise, the frequency increases radially and the signal level is given axially, coded with a color.

The irisgram visualization allows:

- better perception of the plot by users with vision impairment (*e.g.*, color blindness or macular degeneration);
- performing a kind of “irisodiagnosis” of the signal, examining specific patterns and colors of the “signal iris” to determine information about the signal itself, if the personnel are trained enough to work with the irisgram.

The accompanying monochrome color map contributes better reproduction on paper, when black and white printing is used.

Besides, there are two possible inconveniences that could arise when one uses the irisgram – the need of a proper Data Cursor instrument and the possible psychological inertia, when the user is too accustomed with the classical spectrogram visualization. Nevertheless, the irisgram representation is easy to be apprehending, since the way of arrangement of the plot is intuitive enough.

The possible application of this contribution is where the visual representation of the results obtained by STFT is a need. The corresponding Matlab®-function is accessible at:

https://www.mathworks.com/matlabcentral/fileexchange/64882-spectrogram-visualization-with-matlab-implementation

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**[G.7.4] H. Zhivomirov, N. Kostov. Power Parameters and Efficiency of Class B Audio Amplifiers in Real-World Scenario. Radioengineering, ISSN: 1805-9600, DOI: 10.13164/re.2017.0258, Vol. 26, No. 1, pp. 258-262, Apr. 2017.**

A new approach for estimation of the power parameters of the class B amplifiers is proposed, based on RWC (realistic worst-case) scenario of operation with the minimal value of the loudspeaker impedance and a RWC type of signal, instead of the nominal impedance of the loudspeaker and a sine-wave signal, respectively. It is shown that the considered RWC-estimation approximates more accurately the real-world power parameters of the audio amplifier. This is of particular importance when the load impedance profile of the audio amplifier is *a priori* unknown, which is the common case in the practice. Also, assessing of the SOA (safe operating area) boundaries based on the output I-V loci of the amplifier and by means of ELL (equivalent load line) is presented.

The analytical study and the experimental results show that the values of $P_{DC}$ and $P_L$ obtained via the RWC-estimation are always lower than these obtained via the classic approach, but $P_D$ could be greater. Lowering the design requirements to the PSU (power supply unit) of the amplifier and the loudspeaker allows cheaper electronic components, heat sinks, and loudspeakers to be used. This offers opportunities for reducing the prime cost of the product. The awareness about the higher value of $P_D$ in real-world conditions allows an appropriate choice of the active components and heat sink(s) to be made and hence improves the amplifier robustness.

The simulation Matlab® routines concerning the RWC-analysis is accessible on:

http://www.mathworks.com/matlabcentral/fileexchange/47438-power-analysis-of-class-b-power-amplifier-with-matlab-implementation

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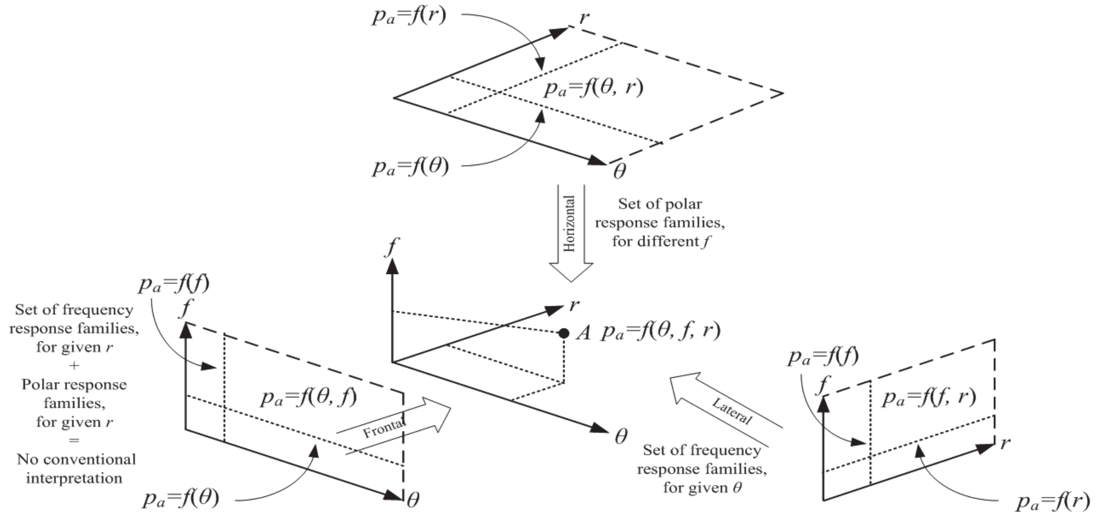
**[G.7.5] I. Iliev, H. Zhivomirov. On the Spatial Characteristics of a Circular Piston. Romanian Journal of Acoustics and Vibration, ISSN: 1584-7284, Vol. XII, No. 1, pp. 29-34, 2015.**

In the paper a theoretical overview of existing and well known mathematical techniques for calculating the sound pressure level (SPL) created by a circular piston in its near and far field is presented.

A unified approach for explaining the acoustic transducers' spatial characteristics is proposed – the study reveals that the acoustic pressure amplitude $p_a(\theta, f, r)$ at given point $A(\theta, r)$ depends on the signal frequency $f$, therefore a 4D plot is to be needed.



Analysis of the proposed visualization needs to be done in sets of slices. Every slice consists of different frequency response or polar response families. The theoretical overview and experimental data analysis reveal that the proposed unified approach is applicable for explaining and understanding the acoustic transducers' spatial characteristics. The polar responses and the frequency responses of given circular pistons are modeled and visualized by means of Matlab®-based scripts.

The figure could be explored in details on:

https://www.mathworks.com/matlabcentral/fileexchange/51136-exploration-of-the-spatial-characteristics-of-a-circular-piston-with-matlab-implementation.

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**[G.8.1] H. Zhivomirov, I. Iliev. Radiation Pattern Measurement with Matlab Implementation. Journal of the Technical University of Gabrovo, ISSN: 1310-6686, Vol. 52, pp. 73-76, 2016.**

In the present paper a Matlab®-based program is developed for measuring the radiation pattern (polar response) of the loudspeaker using data acquisition system NI USB-6211, Matlab® Data Acquisition Toolbox and Matlab® Signal Processing Toolbox.

A definition of the loudspeaker radiation pattern is presented along with block diagrams of the measurement setup and the program algorithm. A comparison between the theoretical and the experimental results has been made. From the comparison of the theoretical and test results one can deduce that the radiation pattern measurement program gives accurate results.

The proposed Matlab® program can be downloaded for free, from:

http://www.mathworks.com/matlabcentral/fileexchange/46233-measurement-of-loudspeaker-radiation-pattern-with-matlab-implementation.

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**[G.8.2] H. Zhivomirov, I. Iliev. Impedance Frequency Response Measurement with Matlab Implementation. Journal of the Technical University of Gabrovo, ISSN: 1310-6686, Vol. 52, pp. 61-65, 2016.**

In the present paper a Matlab®-based program is developed for measuring the impedance frequency response of two-port circuits using data acquisition system NI USB-6211, Matlab® Data Acquisition Toolbox and Matlab® Signal Processing Toolbox.

A brief theoretical analysis is given including the concept of complex impedance and frequency response, the Maximum Likelihood (ML) method for signal amplitude and phase estimation, and a simple method for phase correction due to non-instantaneous sampling in DAQ-system. Block diagrams of the experimental setup and the program algorithm are presented. It uses a sine wave signal with stepwise increasing frequency. By DFT and ML estimation of the amplitudes and the phases of the voltage across- and the current through- the one-port circuit are measured. Then the impedance modulus and phase is calculated.

A comparison and analysis between the theoretical and experimental data has been made and conclusions about the measurements are drawn.

The proposed Matlab® program can be downloaded for free, from http://www.mathworks.com/matlabcentral/fileexchange/50637-impedance-frequency-response-measurement-with-matlab-implementation. With slight alterations in the program code the latter could be used for frequency response measurements of two-port circuits.

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**[G.8.3] H. Zhivomirov, I. Iliev. Generation of Measurement Signals with Matlab Implementation. Acoustics, ISSN: 1312-4897, Vol. 15, pp. 87-90, 2013.**

In the present paper the generation of test signals, used for acoustic and audio measurements, is considered. The generation of the signals is accomplished through Matlab® file-functions.

In the beginning, short theoretical definitions of the generated signals are given.

Further, Matlab® scripts for generation of each of the signals are suggested.

The developed functions provide a generation of:

1) Sine wave signal
2) Square wave signal
3) Triangular wave signal (incl. sawtooth)
4) Sweep signal
5) White noise signal
6) Pink noise signal
7) Sinc wave signal (sin(x)/x)

Each function generates a specific type of signal with arbitrary duration, pause, and number of repetitions of the “wave packet” / “wave train” (if any).

Finally, some conclusions with practical value have been made.

The proposed Matlab® scripts can be downloaded for free, from the link:

http://www.mathworks.com/matlabcentral/fileexchange/43802-generation-of-audio-test-signals-with-matlab-implementation.

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**[G.8.4] H. Zhivomirov, G. Dimitrov. Some Characteristics of the High-pass RC-networks in the Differential Amplifiers. Acoustics, ISSN: 1312-4897, Vol. 14, pp. 82-88, 2012.**

The paper presents a theoretical analysis of the *RC*-networks used in the op-amp circuits as well as an experimental study of their operation in an experimental model of an instrumentation differential operational amplifier.

The ability to compensate the asymmetry of input the high-pass circuits has been validated theoretically and practically which significantly improve the *CMRR* of the amplifier.

The resulting analytical and experimental results can be successfully used in designing, testing and tuning various differential and instrumental amplifiers for the needs of audio engineering, hydro-acoustics, measuring equipment, and more.

**Equation Chapter 1 Section 1**

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**[G.8.5] H. Zhivomirov. Amplifiers Noise Measurement with Matlab Implementation. Third International Scientific Congress Proceedings, ISBN: 978-954-20-0551-3, Vol. 2, pp. 32-37, 2012.**

In the paper two methods for measurement of the noise parameters are considered – measurement by oscilloscope and measurement by TRMS-voltmeter. The practical measurements are performed with application of A-weighted filter (https://www.mathworks.com/matlabcentral/fileexchange/46819-a-weighting-filter-with-matlab) integrated into software in Matlab environment (accessible at https://www.mathworks.com/matlabcentral/fileexchange/37526-noise-measurement-with-matlab) and by PCSGU250 measurement complex. The results from the measurements of an audio power amplifier are shown and practical considerations for their performing are discussed.

The possible applications of the presented work include the fields of the audio engineering, microelectronics *etc*., where the measurement of the noise parameters of devices is a must.

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**[G.8.6] H. Zhivomirov. Design of an automatic gain control system for Wien bridge oscillator. Acoustics, ISSN: 1312-4897, Vol. 12, pp. 27-32, 2010.**

In the presented paper, a methodology for design of AGC system for Wien bridge oscillator using a JFET transistor is proposed.

The consistency of the proposition has been demonstrated by simulation and measurements of a real-world oscillator with AGC. A THD of 0.018% (-75 dB) is achieved, which is significantly higher than the capabilities of the used LM4562 op-amp. This gives reason to claim that its value under the given conditions depends mainly on the parameters of the detector circuit and especially of the time constant of the low-pass filter.

The proposed AGC system can be used to optimize of already existing oscillators or in the design of new ones, as well as in all applications where accurate signal level maintenance is required.