INFOTEHNOLOOGIA TEADUSKOND
THOMAS JOHANN SEEBECKI ELEKTROONIKAINSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012

1. Instituudi struktuur

Thomas Johann Seebecki elektroonikainstituut, Department of Electronics
Instituudi direktor Toomas Rang

- Elektroonikadisaini õppetool, Chair of Electronics Design, Toomas Rang
- Rakenduselektroonika õppetool, Chair of Applied Electronics, Toomas Parve
- Sensorsignaalitöötluse õppetool, Chair of the sensor signal processing, Olev Märtens

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

2.1. Description of the research activities:

Semiconductor Electronics (BaseLab MINAKO, including the Chair Electronics Design**)**
Experimental and numerical study of wide and semi-wide bandgap materials based semiconductor devices; design and fabrication of improved semiconductor components using non-traditional technologies (e.g. DWT); Specific investigations (DLTS spectroscopy, numerical experiments) of electro-physical parameters (deep levels and their influence on electrical characteristics) in semiconductor structures.

Most important results:

- Detection of the new phenomena in SiC semiconductor structures using Kelvin probe surface investigations linking the surface potential with the distribution of dislocations on the surface of the diode chip. We stated that the location of threading dislocations is clearly visible in spite of the fact that the resolution of the method itself looses it's detection capability already eralier.
- The numerical experiment showed clear deep level influence on electrical charactersitics due to the decrease of the capture centres cross section in the trap cluster, which is supported by positively charged donor traps influence on the hole current through the potential barrier.

System Electronics, bionics and Signal processing (Baselab SIE, including Chair of Applied Electronics and Chair of the Sensor Signals Processing**)**

Design of new signal processing methods and tools for smart instruments; precision circuits and systems (impedance spectroscopy, chirp-signals, etc.); test and measurement methods for diagnostics and medical diagnosis; fabrication methods for microfluidic lab-on-chips and signal processing solutions for analysing of micro-droplets; new impedance measurement based solutions for improvement of energy consumption in portable mobile devices. Creation and modification of MATLAB application that uses CCO (Constrained Constructive Optimization) algorithm for generating vascular networks in small tissue scale. Generating a 3D 1cm cube tissue arterial network model and a 3D tissue arterial network model as 1 layer in 1cm square tissue flap. Developing

methods for introducing pulsatile dynamics into the generated 3D vascular networks. Modeling the 1 layer arterial network with pulsatile blood volume change.
Simulating electric impedance measurement with 2 electrodes on the dynamic 3D vascular 1 layer network. The results of the simulation were impedance signals that show changing impedance signal due to pulsatile blood-flow in the small tissue patch. Research of the adaptively oversampled and modulated conversion and processing algorithms of signals with applications mainly in the impedance spectroscopy and image processing, for end-applications in research of the materials and structures like smart composites: design and manufacturing of possibilities of embedding sensors, communication, signal processing and energy harvesting solutions inside of the composite materials; solutions for precise measurement of the properties of alloys and (Euro-)coins has been developed and investigated, mainly by using of the methods of the impedance spectroscopy; investigation of possibilities of developing of novel solutions and algorithms for the fast and precise profiling of the roads, by using of the laser projection and smart image processing

Most important results:

- Novel principles for synthesis, generation and processing of signals used for identification and diagnosing of objects (biological and physiological, chemical and electrochemical, electrically conducting and semi-conducting etc. materials, structures, organs, devices and systems) with the aim to obtain the required information more faster and precisely. The signal processing covers short-time frequency domain methods, implemented for the measurement of transfer functions of the objects performing the broad-band spectroscopy (e.g., impedance spectroscopy) using the designed task specific processors.
- As results of the all mentioned projects, publishing and sometimes patenting, of the main results is going on. Also, in some cases *__demonstrators__* of the novel algorithms and solutions with improved performance has been developed, as described in the corresponding papers.

2.2. six selected publications.

- Trebbels, D.; Fellhauer, F.; Jugl, M.; Haimerl, G.; Min, M.; Zengerle, R. (2012). On-line Tissue Discrimination for Transcutaneous Needle Guidance Applications Using Broadband Impedance Spectroscopy. IEEE Transactions on Biomedical Engineering, 59(2), 494 - 503.
- Mizsei, János; Korolkov, Oleg; Sleptsuk, Natalja; Toompuu, Jana; Rang, Toomas (2012). Investigation of Additional States in the Silicon Carbide Surface after Diffusion Welding. Materials Science Forum, 717-720, 275 - 278.
- Min, Mart; Ojarand, Jaan; Märtens, Olev; Paavle, Toivo; Land, Raul; Annus, Paul; Rist, Marek; Reidla, Marko; Parve, Toomas (2012). Binary Signals in Impedance Spectroscopy. Proceedings of the 2012 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2012) (1 - 4). New Jersey: IEEE Conference Publications
- Koel, Ants; Rang, Toomas; Rang, Galina (2012). Numerical analysis of the influence of deep energy level traps in SiC Schottky structures. W.P. de Wilde, C.A. Brebbia, S. Hernandez (Toim.). High Performance Structures and Materials VI (439 - 448). Great Britain: WIT Press
- Mölder, A.; Reidla, M.; Martens, O.; Land, R. (2012). Feasibility study: a DM3730-based data acquisition and processing solution. In: EDERC 2012 Proceedings of the 5th European

DSP in Education & Research Conference: EDERC 2012, 5th European DSP in Education & Research Conference, 13-14 September 2012 Amsterdam, the Netherlands. (Toim.) J.J. Soraghan, S. Weiss, D. Marinkovic, I. Bannov, and N. Llin. Amsterdam: IEEE, 2012, 58 - 61.

- Mõlder, H.; Järvik, J.; Vaimann, T.; Gordon, R. (2012). Multi-Electrode Arc Furnace Technology with Improved Metal Processing Capability Using Current Driven Mixing. In: Conference Proceedings: 2012 11th International Conference on Environment and Electrical Engineering, Venice, May 18-25. IEEE, 2012, 313 - 316.

2.3. Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustustest.
Sel aastal ei ole.

2.4. Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

Toomas Rang, Mart Min, Olev Märtens, Paul Annus on IEEE erinevate osakondade (*societies*) liikmed.

2.5. Aruandeaasta tähtsamad T&A finantseerimise allikad.

Sihtfinantseeritav teema T061; Energiasäästlikud elektroonikasüsteemid; TAR8077IE, Integreeritud elektroonikasüsteemide ja biomeditsiinitehnika tippkeskus CEBE; 3 ETF granti ja 3 lepingut välisriikidega (EL raamprogramm ja ettevõtlus), 2 Eesti riiklikku programmi (energiatehnoloogiad ja materjalitehnoloogia).

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

Ei soovi

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused *(Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel)*

- Haridus- ja Teadusministeerium

– sihtfinantseeritavad teemad:
T061, Energiasäästlikud elektroonikasüsteemid, Min Mart (2012 – 2014)

– baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
– riiklikud programmid:

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:

- Uurija-professori rahastamine:

- SA Eesti Teadusfond/Eesti Teadusagentuur

– grandid:

ETF9394, Elektriliste kudede diagnostikameetodite arendamine veresoonkonna dünaamilisi mõjutusi arvestades, Gordon Rauno (2012 – 2014)

ETF8905, Adaptiivselt ülevõendatud ja moduleeritud signaalide muundamise ja töötlemise algoritmide uurimine, Märtens Olev (2011 – 2013)

ETF8592, Laia keelutsooniga materjalidel baseeruvad integreeritud Schottky ja heterosiirded: tehnoloogiad ja modelleerimine, Rang Toomas (2011 – 2014)

– ühisgrandid välisriigiga:

– järeldoktorite grandid (SA ETF ja Mobilitas):

MJD5, Giannitsis Athanasios, Development of a Microfluidic lab-on-chip for bioimpedance measurements on droplet-based bioreactors (1.09.2009 - 31.08.2012)

– tippteadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA

– eeluuringud:

– arendustoetused:

- SA Archimedesega sõlmitud lepingud

– infrastruktuur (nn „mini-infra“, „asutuse infra“):

AP061, Energiasäästlikud elektroonikasüsteemid, Min Mart (1.01.2012 - 31.12.2013)

ÜLTAP29-1, Energiasäästlikud mikro- ja nanostruktuursed sardsüsteemid ja komponendid (SARS4), Eva Keerov (1.06.2012 - 18.01.2014)

ÜLATP15-3, Mikro- ja nanostruktuursed sardsüsteemid ja komponendid (SARS3), Toomas Rang (1.06.2011 - 7.07.2013)

ÜLTAP61, Integreeritud elektroonsed süsteemid ja komponendid (SARS2), Toomas Rang (1.05.2010 - 19.04.2012)

– Eesti tippkeskused:

TAR8077IE, Integreeritud elektroonikasüsteemide ja biomeditsiinitehnika tippkeskus, Mart Min (7.07.2008 - 31.08.2015)

– riiklikud programmid:

AR10126, Energiatehnoloogia,ENERGIASÜSTEEMI TALITLUSE OPTIMEERIMINE MUUTUVKOORMUSTE TASAKAALUSTAMISEKS, Alvar Kurrel (1.11.2010 - 31.10.2013)

AR12118, materjalitehnoloogia, Efficient plasmonic absorbers for solar cells, Alvar Kurrel (1.07.2012 - 31.12.2014)

– muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

- EL Raamprogrammi projektid:

VFP463, Mikrovedelike kiip, Giannitsis Athanasios (1.04.2010 - 30.09.2012)

VFP494, Turvametall, Märtens Olev (30.11.2010 - 29.11.2012)

- Välisriiklikud lepingud:

VE546, Teostatavuse analüüs bioimpedantsi mõõtmise kasutamiseks toiduainete valmistamise juhtimisel ja kontrollimisel, Min Mart (1.01.2012 - 31.03.2012)

2.8 Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid *(ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1).*

1.1

Paavle, Toivo, Min, Mart (2012). Discrete-Level Broadband Excitation Signals: Binary/Ternary Chirps. Electronics and Electrical Engineering, 6(122), 23 - 26.

Ivanov, P.; Grekhov, I.; Potapov, A.; Kon'kov, O.; Il'inskaya, N.; Samsonova, T.; Korolkov, O.; Sleptsuk, N. (2012). Leakage Currents in 4H-SiC JBS Diodes. Semiconductors, 46(3), 411 - 415.

Trebbels, D.; Fellhauer, F.; Jugl, M.; Haimerl, G.; Min, M.; Zengerle, R. (2012). On-line Tissue Discrimination for Transcutaneous Needle Guidance Applications Using Broadband Impedance Spectroscopy. IEEE Transactions on Biomedical Engineering, 59(2), 494 - 503.

Sleptsuk, Natalja; Korolkov, Oleg; Toompuu, Jana; Rang, Toomas; Mikli, Valdek (2012). The Specificity of Solid-Phase Interaction of Aluminium with Silicon Carbide in the Manufacture of Diffusion-Welded Contacts to Semiconductor Devices. ELECTRONICS AND ELECTRICAL ENGINEERING, 18(8), 45 - 48.

Mizsei, János; Korolkov, Oleg; Sleptsuk, Natalja; Toompuu, Jana; Rang, Toomas (2012). Investigation of Additional States in the Silicon Carbide Surface after Diffusion Welding. Materials Science Forum, 717-720, 275 - 278.

1.2

Blinov, A.; Vinnikov, D.; Rang, T. (2012). SiC и GaAs Диоды в Устройствах Силовой Электроники. Технічна електродинаміка, 42-46

Glazov, Aleksei; Kozlov, Vladimir; Korolkov, Oleg.; Muratikov, Kirill (2012). Анализ процессов распросттранения тепла в структурах импульсных силовых приборов вблизи плоскостей спая кремниевых пластин в высоковольтные "столбы". Материалы электронной техники, 2, 65 - 69.

Ivanov, Pavel; Grekhov, Ilya; Potapov, Alexander; Kon'kov, O.; Il'inskaya, N.; Samsonova, Tatyana; Korolkov, Oleg; Sleptsuk, Natalja (2012). Токи утечки в 4H-SiC-диодах Шоттки с интегрированной шоттки (p−n- структурой). Физика и техника полупроводников (411 -

415).Российская академия наук

1.3

2.1

2.2

Sleptsuk, N. (2012). Intermediate layer in the metal-silicon carbide contact. Lambert Academic Publishing

3.1

Min, Mart; Ojarand, Jaan; Märtens, Olev; Paavle, Toivo; Land, Raul; Annus, Paul; Rist, Marek; Reidla, Marko; Parve, Toomas (2012). Binary Signals in Impedance Spectroscopy. Proceedings of the 2012 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2012) (1 - 4). New Jersey: IEEE Conference Publications

Annus, P.; Min, M.; Rist, M.; Ojarand, J.; Land, R. (2012). Current source considerations for broadband bioimpedance spectroscopy. Olfa Kanoun (Toim.). Lecture Notes on Impedance Spectroscopy: Measurement, Modeling and Applications (63 - 73). London: Taylor & Francis

Rist, M.; Annus, P.; Jaansoo, T. (2012). Handheld impedance measurement platform for preliminary analysis in biomedicine and technology. O. Kanoun (Toim.). Lecture Notes on Impedance Spectroscopy: Measurement, Modeling and Applications (75 - 82). London: Taylor & Francis

Koel, Ants; Rang, Toomas; Rang, Galina (2012). Numerical analysis of the influence of deep energy level traps in SiC Schottky structures. W.P. de Wilde, C.A. Brebbia, S. Hernandez (Toim.). High Performance Structures and Materials VI (439 - 448). Great Britain: WIT Press

Min, M.; Parve, T.; Land, R.; Annus, P. (2012). Scalable Impedance Spectroscopy: comparative study of sinusoidal and rectangular chirp excitations. Olfa Kanoun (Toim.). Lecture Notes on Impedance Spectroscopy: Measurement, Modeling and Applications (33 - 38). London: Taylor & Francis

Mihhailov, J.; Strik, S. (2012). A continuous output current measurement circuit for switching step down DC-DC regulator with a single sensing FET. In: Proceedings of the 13th Biennial Baltic Electronics Conference: 2012 13th Binnial Baltic Electronics Conference. Tallinn, Estonia; IEEE Catalog Number: CFP12BEC-PRT: TTU Press, 2012, 65 - 68.

Molder, A.; Martens, O.; Saar, T. (2012). Adaptively undersampled, circular histogram based image processing for rotation invariant coin detection. In: BEC 2012 : 13th biennial Baltic Electronics Conference : proceedings of the 13th biennial Baltic Electronics Conference : Tallinn University of Technology, October 3-5, 2012, Tallinn, Estonia: 2012 13th Biennial Baltic Electronics Conference (BEC2012), Tallinn, Estonia, October 3-5, 2012. IEEE, 2012, 137 - 140.

Ojarand, J.; Land, R.; Min, M. (2012). Comparison of Spectrally Sparse Excitation Signals for Fast Bioimpedance Spectroscopy. In the context of cytometry. In: Proceedings of the 7th International Workshop on Medical Measurements and Applications (MeMeA2012): 7th International Workshop on Medical Measurements and Applications (MeMeA2012): Budapest, Hungary, May 18-19, 2012, IEEE. , 2012, 214 - 218.

Gavrijaseva, A.; Molder, A.; Martens, O.; Kyrkou, C.; Theocharides, T. (2012). Cross-Correlation-

based Image Matching of Coins. In: BEC 2012 : 13th biennial Baltic Electronics Conference : proceedings of the 13th biennial Baltic Electronics Conference : Tallinn University of Technology, October 3-5, 2012, Tallinn, Estonia: 2012 13th Biennial Baltic Electronics Conference (BEC2012), Tallinn, Estonia, October 3-5, 2012. IEEE, 2012, 319 - 322.

Udal, A.; Reeder, R.; Ikonic, Z.; Harrison, P.; Velmre, E. (2012). Development of quantum cascade laser simulation software. In: BEC 2012 : 13th biennial Baltic Electronics Conference : proceedings of the 13th biennial Baltic Electronics Conference : Tallinn University of Technology, October 3-5, 2012, Tallinn, Estonia: IEEE, 2012, 47 - 48.

Blinov, Andrei; Vinnikov, Dmitri; Rang, Toomas (2012). Experimental analysis of the dynamic performance of Si, GaAs and SiC diodes. In: Proceedings of the 13th Biennial Baltic Electronics Conference: 2012 13th Binnial Baltic Electronics Conference. (Toim.) Toomas Rang, Peeter Ellervee. Tallinn, Estonia; IEEE Catalog Number: CFP12BEC-PRT: TTU Press, 2012, 49 - 52.

Mizsei, J?nos; Korolkov, Oleg; Sleptsuk, Natalja; Toompuu, Jana; Rang, Toomas (2012). Experimental study of surface distorsions in silicon carbide caused by diffusion welding. In: Proceedings of the 13th Biennial Baltic Electronics Conference: 2012 13th Binnial Baltic Electronics Conference. (Toim.) Toomas Rang, Peeter Ellervee. Tallinn, Estonia; IEEE Catalog Number: CFP12BEC-PRT: TTU Press, 2012, 53 - 56.

Molder, A.; Reidla, M.; Martens, O.; Land, R. (2012). Feasibility study: a DM3730-based data acquisition and processing solution. In: EDERC 2012 Proceedings of the 5th European DSP in Education & Research Conference : EDERC 2012, 5th European DSP in Education & Research Conference , 13-14 September 2012 Amsterdam, The Netherlands. (Toim.) J.J. Soraghan, S. Weiss, D. Marinkovic, I. Bannov, and N. Llin. Amsterdam: IEEE, 2012, 58 - 61.

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Nõmm, Sven; Kuusik, Alar; Ovsjanski, Sergei; Malmberg, Ines; Parve, Marko; Orunurm, L. (2012). Neural networks based system for the supervision of therapeutic exercises. In: Neural Information Processing : 19th International Conference, ICONIP 2012, Doha, Qatar, November 12-15, 2012, Proceedings, Part IV: (Toim.) Huang, Tingwen; Zeng, Zhigang; Li, Chuandong; Leung, Chi Sing. Berlin: Springer, 2012, (Lecture Notes in Computer Science; 7666), 364 - 371.

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Paisnik, Kristo; Poppe, Andr?s; Rang, Toomas; Rang, Galina (2012). Physics related modeling of power LEDs. In: Proceedings of the 13th Biennial Baltic Electronics Conference: 2012 13th Binnial Baltic Electronics Conference. (Toim.) Toomas Rang, Peeter Ellervee. Tallinn, Estonia; IEEE Catalog Number: CFP12BEC-PRT: TTU Press, 2012, 57 - 60.

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Paavle, Toivo; Min, Mart (2012). Rectangular-Wave Chirps for Broadband Measurement: Spectra and Energy. In: Proceedings of the 13th Biennial Baltic Electronics Conference: 13th Biennial Baltic Electronics Conference (BEC2012), Tallinn, Estonia, October 3-5, 2012. Tallinn, Estonia: IEEE Operations Center, 2012, 195 - 198.

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3.2

Paavle, Toivo; Min, Mart; Parve, Toomas (2012). Aspects of Using Chirp Excitation for Estimation of Bioimpedance Spectrum. Salih Mohammed Salih (Toim.). Fourier Transform - Signal Processing (237 - 256). Rijeka, Croatia: InTech - Open Access Publisher

Annus, P.; Land, R.; Min, M.; Ojarand, J. (2012). Simple Signals for System Identification . S. M. Salih (Toim.). Fourier Transform - Signal Processing (257 - 276).InTech - Open Access Publisher

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Gordon, R.; Pesti, K. (2012). System for bioimpedance signal simulation from pulsating blood flow in tissues. In: International workshop on impedance spectroscopy: IWIS, Chemnitz, September 26-28, 2012. , 2012, 22 - 23.

Rist, M.; Reidla, M.; Min, M.; Parve, T.; Martens, O.; Land, R. (2012). TMS320F28069-based impedance spectroscopy with binary excitation. In: EDERC 2012 Proceedings of the 5th European DSP in Education & Research Conference : EDERC 2012, 5th European DSP in Education & Research Conference , 13-14 September 2012 Amsterdam, The Netherlands. (Toim.) J.J. Soraghan, S. Weiss, D. Marinkovic, I. Bannov, and N. Llin. Amsterdam: Texas Instruments, 2012, 217 - 220.

Reidla, M.; Martens, O.; Land, R. (2012). TMS320F28335-based high-accuracy complex network analyzer instrument. In: EDERC 2012 Proceedings of the 5th European DSP in Education & Research Conference : EDERC 2012, 5th European DSP in Education & Research Conference , 13-14 September 2012 Amsterdam, The Netherlands. (Toim.) J.J. Soraghan, S. Weiss, D. Marinkovic, I. Bannov, and N. Llin. Amsterdam: Texas Instruments, 2012, 44 - 47.

3.3

4.1

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5.1

Mizsei, J?nos; Korolkov, Oleg; Toompuu, Jana; Rang, Toomas (2012). Study of surface defects in 4H-SiC Schottky diodes using a scanning Kelvin probe. The 9th European Conference of Silicon Carbide and Related Materials. Abstract Book, St. Petersburg Russia; 2-6 Sept. 2012 (TuP40). St. Petersburg: Trans Tech Publications Ltd

Giannoukos, Georgios (2012). Mathematical and physical modelling of atherosclerosis in terms of the alterations of the dynamic electrical impedance of the arteries . In: American Institute of Physics - AIP Conference Proceedings : International Conference of Numerical Analysis and Applied Mathematics ICNAAM 2012,19–25 September 2012, Kos, Greece.. Melville, New York: American Institute of Physics, 2012, 2174 - 2177.

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu *(NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu)*

Jaan Ojarand, Thomas Johann Seebecki elektroonikainstituut
Teema: *Wideband Excitation Signals for Fast Impedance Spectroscopy of Biological Objects*
(Lairiba ergutussignaalid bioloogiliste objektide kiiretoimelise bioimpedants-spektroskoopia jaoks)
Juhendajad: juhtivteadur Mart Min ja PhD Uwe Pliquett
Kaitses: 21.12.2012
Omistatud kraad: filosoofiadoktor (elektroonika)

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu *(ETIS-e kaudu esitatud taotluste alusel)*

Giannitsis Athanasios, Development of a Microfluidic lab-on-chip for bioimpedance measurements on droplet-based bioreactors (1.09.2009 - 31.08.2012)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

EP12182280.3
Method and device for broadband analysis of systems and substances
Taotlus esitatud: 29.08.2012
Autorid: Raul Land, Paul Annus, Mart Min, Olev Märtens, Jaan Ojarand
Omanikud: TTÜ, ELIKO Tehnoloogia Arenduskeskus OÜ

US13/598955
Method and device for broadband analysis of systems and substances
Taotlus esitatud: 30.08.2012
Autorid: Raul Land, Paul Annus, Mart Min, Olev Märtens, Jaan Ojarand
Omanikud: TTÜ, OÜ ELIKO Tehnoloogia Arenduskeskus

EE05600B1
Meetod vigade minimiseerimiseks ebaühtlaselt diskreeditud signaalide töötlemisel ja demoduleerimisel laiaribaliste mitmesageduslike mõõtmiste jaoks
Patent välja antud: 17.12.2012
Autorid: Ivars Bilinskis, Mart Min, Jurijs Artjuhs, Paul Annus, Raul Land, Olev Märtens.

Omanik: TTÜ

EE05616B1
Meetod ja seade sageduskarakteristiku mõõtmiseks
Patent välja antud: 17.12.2012
Autorid: Olev Märtens, Mart Min, Raul Land, Paul Annus, Tõnis Saar, Marko Reidla
Omanikud: TTÜ OÜ ELIKO Tehnoloogia Arenduskeskus

EE05618B1
Meetod siinussignaalide ristumisel põhinevaks andmehõiveks ebaühtlase asetusega sensorvõredelt
Patent välja antud: 17.12.2012
Autorid: Ivars Bilinskis, Mart Min, Aleksanders Ribakovs
Omanik: TTÜ

EP2313001B1
Method and device using shortened square wave waveforms in synchronous signal processing
Patent välja antud: 01.02.2012
Autorid: Paul Annus, Mart Min, Jaan Ojarand
Omanikud: TTÜ, ELIKO TAK

DE602009005068
Verfahren Und Vorrichtung Mit Gekürzten Quadratischen Wellenformen Bei Der Synchronen Signalaufbereitung
Patent välja antud: 01.02.2012
Autorid: Paul Annus, Mart Min, Jaan Ojarand
Omanikud: TTÜ, ELIKO TAK

GB-EP2313001B1
Method and device using shortened square wave waveforms in synchronous signal processing
Patent välja antud: 01.02.2012
Autorid: Paul Annus, Mart Min, Jaan Ojarand
Omanikud: TTÜ, ELIKO TAK

US8223020B2
Method and device for synchronization of a decoder of a RFID receiver
Patent välja antud: 17.07.2012
Autorid: Olev Märtens, Alar Kuusik, Aivar Liimets
Omanikud: TTÜ, ELIKO TAK

EE05617B1
Meetod digitaalse sisu relevantsuse määramiseks
Patent välja antud: 17.12.2012
Autor: Alar Kuusik
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3. Struktuuriüksuse infrastruktuuri uuendamise loetelu *(summa eurodes)*

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