# CV

Application for promotion to Senior Lecturer in Industrial Electronics

2015-06-17

# 1 Personal data

## 1.1 Name

Johan Borg

## 1.2 Date of birth

1978-10-06

## 1.3 Home Address, Phone Number, E-mail and Homepage

Docentvägen 157, Luleå
0920-491577
joborg@ltu.se
None

## 1.4 Present employment

Luleå University of Technology, September 2011-present, Associate Senior Lecturer

## 1.5 Previous employments

Luleå University of Technology, 2005-2010, PhD student
Luleå University of Technology, Jan-Sept 2011, Researcher

## 1.6 Additional Information

# 2 Educational Degrees

## 2.1 Undergraduate and Graduate Degrees

- M.Sc in "Applied Physics and Electrical Engineering" from Linköping University, Sweden, 2003

## 2.2 Licentiate and/or PhD Degree

- Ph.D in "Industrial electronics", Luleå University of Technology, Sweden, 2010

## 2.3 Associate Professor Competence

## 2.4 Additional Information

# 3 Scientific Merits

## 3.1 Research Profile

Most of my research after my Ph.D. has been related to one of two projects; the EISCAT_3D and the ePellet projects. The overall goal of the EISCAT_3D project is to build a next-generation ionospheric research radar system using multi-static antenna arrays. My work for this project can be divided into: RF front-end design, antenna array calibration methods, and antenna design. In the first part the trade-offs inherent in designing equipment for noise characterization of transistors was investigated, the equipment was designed and used for characterizing promising transistors. This data was used with a combination of analytical network theory, numerical optimization and exhaustive search to find the best overall device when both noise contributions from the active devices and all required impedance matching components were included, while maintaining an acceptable return-loss towards the antenna. In order to facilitate calibration through signal injection, microstrip coupling circuits were investigated and an microstrip slot coupler with asymmetric ground-plane was designed that minimizes the resistive losses in the input signal path. My work on calibration systems for antenna arrays included

work on a type of signal injection system that is inherently insensitive to variations in the lengths of the cables used to distribute the calibration signal. Electrical simulations were used for determining the robustness of such systems against variations in various electrical parameters within the system, so that relevant specifications can be formulated for the individual components. I also investigated the integration time required when using the noise emitted by celestial radio sources visible from the intended location for the EISCAT_3D system for calibrating a receiving antenna array, and similarly estimating the integration time when using radar reflections from known objects in earth orbit to calibrate both the transmitting and the receiving antenna arrays. My work on antenna design for antenna arrays was based on finding and visualizing optimal trade-offs between different combinations of bandwidth, steering angle and sensitivity through numerical optimization and exhaustive search over antenna types, dimensions, spacings, intentional mismatch, et.c.

In the ePellets project I worked with one PhD student to improve the detection range of low (125 kHz or 13.56 MHz) RFID tags. Whereas the student worked on theory and circuit design for improved rectification of weak electrical signals my work was related to more practical tasks, including developing a method for magnetic characterization of granular materials without using prohibitively large sample sizes and the design and evaluation of both multiple-coil antennas and improved single-coil antennas for powering low-frequency RFID tags.

## 3.2   Planned Research Activities

In addition to further work towards publishing the results from the work described above (so far only published in project reports and similar), I hope to work mainly within two fields: As a continuation of the work on RFID-tags I hope to work with a new PhD student to develop technology for accurately measuring the position in three dimensions of small specially designed RFID-tags, based on wide-bandwidth RF propagation measurement at as low frequencies as the wide bandwidth permits, to enable using such techniques in environments where high absorption of electromagnetic waves at higher frequencies make measurements difficult. Working with a current PhD student I also hope to further develop methods for monitoring and diagnostics of power semiconductors. I hope to extend currently ongoing work on contactless temperature measurement techniques with investigations into if and how

3

light emissions due to charge recombination in power semiconductors can be used for diagnostic purposes.

## 3.3 List of publications

### 3.3.1 Peer-reviewed Publications in International Journals

- *A lab-on-a-chip for hypoxic patch clamp measurements combined with optical tweezers and spectroscopy- first investigations of single biological cells*
  Alrifaiy, A., Borg, J., Lindahl O., & Ramser, K.
  BioMedical Engineering OnLine, 2015.

  My contribution: Worked with the first author to find a acceptable compromise between mechanical complexity and other requirements on the measurement device. CAD and CNC machining of the microfluidic channels. Worked with the first author to find a solution for gluing the cover glass to the PMMA without filling the microfluidic channels.

- *A CMOS Front-end for RFID Transponders Using Multiple Coil Antennas*
  Rabén, H.,Borg, J. & Johansson, J.
  Analog Integrated Circuits and Signal Processing, 2015.

  My contribution: Design and assembly of the 3D antenna. Whereas the first author designed the circuit I performed all the measurements on the manufactured device.

- *Design of voltage multipliers for maximized DC generation in inductively coupled RFID tags*
  Rabén, H., Borg, J. & Johansson, J
  IEEE Transactions on Circuits and Systems Part 1: Regular Papers, 2014.

  My contribution: Assisted in formulating the underlying idea, in deriving the theory and in shaping the presentation of the results.

- *A measurement system for the position and phase errors of the elements in an antenna array subject to mutual coupling*
  Lindgren, T. & Borg, J
  International Journal of Antennas and Propagation, 2012.

4

My contribution: The description of the theory of how mutual coupling can be described in terms of N-port electrical networks. Input on how this could be applied for the simulations.

- *A model for MOS diodes with vth-cancellation in RFID rectifiers*
  Rabén, H., Borg, J. & Johansson, J
  IEEE Transactions on Circuits and Systems. Part 2: Express Briefs, 2012.

  My contribution: Assisted in formulating the underlying idea and in deriving the theory.

- *Evaluation of a surface-channel CCD manufactured in a pinned active-pixel-sensor CMOS process*
  Borg, J. & Johansson, J.
  IEEE Transactions on Electron Devices, 2011.
  Revised version of paper included in doctoral thesis.

  My contribution: Whole paper.

- *An ultrasonic transducer interface IC with integrated push-pull 40 Vpp, 400 mA current output, 8-bit DAC and integrated HV multiplexer*
  Borg, J. & Johansson, J.
  IEEE Journal of Solid State Circuits, 2011.
  Included in doctoral thesis.

  My contribution: Whole paper.

- *EISCAT_3D - a next-generation European radar system for upper atmosphere and geospace research*
  Wannberg, G., Andersson, H., Behlke, R., Belyey, V., Bergqvist, P., Borg, J., Brekke, A., Delsing, J., Eliasson, L., Finch, I., Grydeland, T., Gustavsson, B., Häggström, I., Harrison, R., Iinatti, T., Johansson, G., Johansson, J., Johansson, J., La Hoz, C., Laakso, T., Larsen, R., Larsmark, M., Lindgren, T., Lundberg Nordenvaad, M., Markkanen, J., Marttala, I., McCrea, I., McKay, D., Postila, M., Puccio, W., Renkwitz, T., Turunen, E., van Eyken, A., Vanhainen, L., Westman, A. & Wolf, I.
  Radio Science Bulletin. 332, 2010.

  My contribution: Design of the fractional-delay beamstearing filters. Design of and simulations on the signal-injection based delay calibra-

tion system with antenna return-loss measurement capability. Design of the LNA, the signal injection system and the digitization electronics for the demonstrator system.

- *Simulation of post-ADC digital beamforming for large aperture array radars*
  Johansson, G., Borg, J., Johansson, J., Lundberg Nordenvaad, M. & Wannberg, G.
  Radio Science. 45, RS3001, 12 p, 2010.

  My contribution: First version of simulation software for generating and evaluating fractional delay filters. This work was continued and extended for the results presented in this paper.

### 3.3.2  Book Chapters

### 3.3.3  Conference Publications

- *Variable-Frequency Drives: Three perspectives*
  Ekman, J., Johansson, J., Lindgren, P. & Borg, J
  Nordic Conference on Electricity Distribution System Management and Development, 2014.
  Full paper.

- *Time-to-Digital Converter using an Analogue Time Stretcher for 3D Time of Flight Camera*
  Tanveer, M., Nissinen, I., Nissinen, J., Kostamovaara, J., Borg, J. & Johansson, J.
  S&T/SPIE Electronic Imaging 2014:Image Sensors and Imaging Systems, 2014.
  Full paper.

- *Design considerations for the EISCAT-3D phased array antenna*
  Beckman, C., Borg, J., Johansson, J. & Tecsor, I
  8th European Conference on Antennas and Propagation, 2014.
  Full paper.

- *Time stretcher for a time-to-digital converter with a precisely matched current mirror*
  Tanveer, M., Borg, J. & Johansson, J.

IEEE International System on Chip Conference, 2014.
Full paper.

- *Time-to-digital converter based on analog time expansion for 3D time-of-flight cameras*
  Tanveer, M., Nissinen, I., Nissinen, J., Kostamovaara, J., Borg, J. & Johansson, J.
  Image Sensors and Imaging Systems, 2014.
  Full paper.

- *A discrete model of the DC charge-up phase in RFID rectifiers*
  Rabén, H., Borg, J. & Johansson, J.
  Proceedings of the 20th International Conference Mixed Design of Integrated Circuits and Systems, 2013..
  Full paper.

- *An active MOS diode with V th-cancellation for RFID rectifiers*
  Rabén, H., Borg, J. & Johansson, J.
  IEEE International Conference on RFID, 2012..
  Full paper.

- *An analogue time stretcher for a 3D time of flight camera*
  Tanveer, M., Borg, J., Kostamovaara, J. & Hyyppä, K.
  International Conference on 3D Converged IT and Optical Communication, 2012..
  Full paper.

- *Architecture for extreme low power sensing in wireless sensor network devices*
  Delsing, J., Borg, J. & Johansson, J
  SENSORCOMM 2011: The Fifth International Conference on Sensor Technologies and Applications, 2011..
  Full paper.

- *Improved efficiency in the CMOS cross-connected bridge rectifier for RFID applications*
  Rabén, H., Borg, J. & Johansson, J
  Proceedings of the 18th International Conference Mixed Design of Integrated Circuits and Systems, 2011..
  Full paper.

- *Incorporation of mechanical noise in the SPICE model of a piezoelectric transducer*
  Johansson, J. & Borg, J.
  Proceedings of the International Congress on Ultrasonics, 2007..
  Full paper.

- *Optimization of the design of an integrated ultrasonic preamplifier*
  Borg, J. & Johansson, J. Proceedings of the International Congress on Ultrasonics, 2007..
  Full paper.

- *Reciprocal operation of ultrasonic transducers: experimental results*
  Borg, J., Johansson, J., Johansson, J., Van Deventer, J. & Delsing, J.
  Ultrasonics Symposium Proceedings, 2006..
  Full paper.

- *Temperature stabilization of electronics module* Gabert, A., Borg, J. & Johansson, J.
  The IMAPS Nordic Annual Conference, 2006..
  Full paper.

### 3.3.4 Additional Publications

- *EISCAT 3D Preparatory Phase Project Deliverable 8.5: Report on all WP8 activities*
  My contribution: Simulations and design of the improved antenna (sections 2.3-2.4), investigation of sensitivity to manufacturing variations (section 2.6) and the computationally efficient method for estimating the local electric field close to the array (section 2.7). The design of the low noise amplifier with signal injection capability (section 3) except for the PCB design of the final mass-producible prototype. Investigation of the theoretical performance and other aspects of methods suitable for calibrating large antenna arrays (sections 4.2-4.5).

- *On electronics for measurement systems*
  Borg, J
  Doctoral thesis, 2010

- *EISCAT 3D Radar Receiver/Antenna Subsystem Report*
  Johansson, J., Johansson, G., Borg, J., Larsmark, M. & Lindgren, T
  EISCAT Scientific Association, 2009.

## 3.4 Approved Research Grants

- Participated in writing the LTU part of the successful application for "Preparatory phase" funding for the EISCAT_3D project from the FP7-INFRASTRUCTURES-2010-1 call. Total budget in application: 6 MEuro. Granted: 4.5 MEuro. LTU/SRT part: 982.5kEuro. Project duration: October 2010 to September 2014. LTU diarienummer (Dnr): 02933-2009.

  My work in this project consisted of research on methods for developing RF-frontends, calibration methods for antenna arrays, synthesis of low-noise amplifier circuits and synthesis of antennas for antenna arrays.

- Major contributions to a successful application to the Hjalmar Lundbohm Research Centre for the "ePellets" project. Total budget: 2580 kSek. Project duration: June 2013 to March 2015. LTU Dnr: 00761-2013.

  My part in this project was to act as assistant supervision for a PhD student, as well as work on characterizing bulk electrical properties of granular materials, and developing proof of concept antennas related to the work of the PhD student.

- The pre-study that led to a successful application to Svenska Kraftnät for studies related to the reliability of variable frequency drives. Total budget: 15 Msek. Duration: August 2014 to December 2018. LTU Dnr: 2191-2013.

  My part in this project is to act as assistant supervisor for one PhD student.

- Minor contributions to an application to the H2020-SPIRE-2014 call for the "Disire" project for the parts related to a continuation of the "ePellets" project. Total budget: 6 MEuro, LTU part: 1.5 MEuro. Project duration: January 2015 to December 2017. LTU Dnr: 00872-2014.

  My part in this project is to act as assistant supervisor for one PhD student and perform own research relevant to the project.

## 3.5 Network/Research Collaboration

Continuous relations with the analog integrated circuits group at the integrated circuits (IIS) branch of the Fraunhofer institute, Germany, and with the EISCAT scientific association, Kiruna.

## 3.6 Popular Science Communication of Research Results

## 3.7 National and International Research Awards

## 3.8 Other Scientific Merits Within and Outside the University

- Peer reviewer: 6 articles.

- Backup grading committee member at the dissertation of Niklas Anderssons at Linköping University, 2015-01-16. Linköping university Dnr: LiU-2014-01881.

# 4 Pedagogical Merits

## 4.1 Pedagogical Education

- University pedagogics 7.5 hp, Luleå university of technology, 2010.

- How can I develop as a teacher, 3 hp, Luleå university of technology, 2008.

## 4.2 Personal Pedagogical Ideology

The most important aspect of teaching is to introduce sufficient organization that students are forced to work with relevant material over a sufficiently extended period of time, at the same time introducing new material at a suitable rate. One way this was applied was in the "Electronics II" course given in the spring of 2015, where the laborations were changed from being mainly a hands-on part of an otherwise theoretical course, to becoming deadlines to which the students were required to work on theory directly related

to each laboration. This, in combination with increased interaction with the students (mainly around the preparations for each lab) appears, based on exam results, to have improved the average understanding of key theoretical concepts covered in the course.

I find it useful to encourage questions from students not only at lectures or labs, but also outside of the hours scheduled for the course. For one thing, it makes it possible to use more challenging assignments and thus ensuring that the contents remains properly challenging for a larger part of the students by offering readily available additional help to individuals or groups when required. This also results in more immediate feedback on the difficulty of the tasks and on what parts of the material that has been presented at lectures that may need repeating or clarifying at future lectures. For maximum effect it is of course necessary to carefully select what to answer and how to present the answer. For example, it can be possible to encourage the students to study a problem on their own by, before going into details on how to proceed, by making them explain in some detail their attempts/conclusions so far. Similarly, the level of details given in the answer needs to be adopted to the talent of the student so that neither too much or too little is left for the student to do on their own.

## 4.3   Educational Achievements

- Spring 2015: Integrated circuits 7.5hp (Lectures, lab and project supervision).

- Autumn 2014: Electronics Design 7.5hp (Lectures, lab and project supervision).

- Autumn 2013: Electronics Design 7.5hp (Lectures, lab and project supervision).

- Spring 2013: Integrated circuits 7.5hp (Lectures, lab and project supervision).

Lab assistant:

- Spring 2015: Electronics II, Main teacher: Jonny Johansson.

- Spring 2014: Electronics II, Main teacher: Jonny Johansson.

- Autumn 2008: Electronics, Main teacher: Jonny Johansson.

- Spring 2007: Electronics, Main teacher: Jonny Johansson.

- Autumn 2006: Electronics II, Main teacher: Kalevi Hyyppä.

- Autumn 2005: Measurement technology, Main teacher: Johan Carlsson.

- Autumn 2005: Electronics II, Main teacher: Kalevi Hyyppä.

## 4.4   Supervision

Doctoral dissertations:

- Hans Rabén, 2014-12-12, DC Generation for Inductively Coupled RFID Systems, Co-supervisor.

Licentiate dissertations:

- Hans Rabén, 2012-06-18, Rectifiers in CMOS for RFID applications, Co-supervisor.

- Muhammad Tanveer, 2014-06-09, Design of Time-to-Digital Converter Circuits for 3D Time-of-Flight Measurements, Co-supervisor.

Masters thesis supervisor for 4 works, bachelors thesis supervisor for 1 work.

Master's thesis supervisor (works performed at LTU):

- Anders Gabert, "Temperature stabilization of electronics module", 2006.

- Marcus Edwall, "Low-noise amplifier design and optimization", 2008.

Master's thesis supervisor (LTU representative for works performed elsewhere):

- Joakim Bergs, "Design of a VCO based ADC in a 180 nm CMOS process for use in positron emission tomography", performed at Fraunhofer IIS, Erlangen, Germany, 2010.

- Tobias Tiger, "Educational Device for Detection of Harmful Sound Levels", performed at CVK, Luleå, 2014.

Bachelor's thesis supervisor:

- Thomas Myllymäki and Andreas Söder, "Pick and place user interface", 2009.

## 4.5   Teaching Material

- E7015E (Integrated circuits) 2015: Complete rework of 2 labs and of the design project.

- E7014E (Electronics II) 2015: Complete rework of 3 out of 6 labs.

- E7014E (Electronics II) 2014: Minor updates of lab instructions.

- E7009E (Electronics design) 2014: Added one additional labs, minor updates of the other labs. Added 3 more lectures.

- E7009E (Electronics design) 2013: Updated lab instructions for 2 labs, added one lab. New lectures created after taking over the course from another teacher.

- E7015E (Integrated circuits) 2013: Updated 3 labs. New lectures created after taking over the course from another teacher.

- E7015E (Integrated circuits) 2008: Helped develop and test design and simulation exercises. Main teacher: Jonny Johansson.

**4.6 Educational Planning and Administration**

**4.7 Network/Pedagogical Collaborations**

**4.8 Pedagogical Awards**

**4.9 Additional Pedagogical Merits**

# 5 Management Positions

# 6 Additional Assignments

**6.1 Chair/Board Member during the Last Five Years**

**6.2 Business Experience**

**6.3 Pro bono Work/Positions of Trust**

# 7 References

- Jonny Johansson, Associate professor, Luleå University of Technology. jonny.johansson@ltu.se, +46 920 491703.

- Jerker Delsing, Professor, Luleå University of Technology. jerker.delsing@ltu.se, +46 920 491898