DANISH SOUND

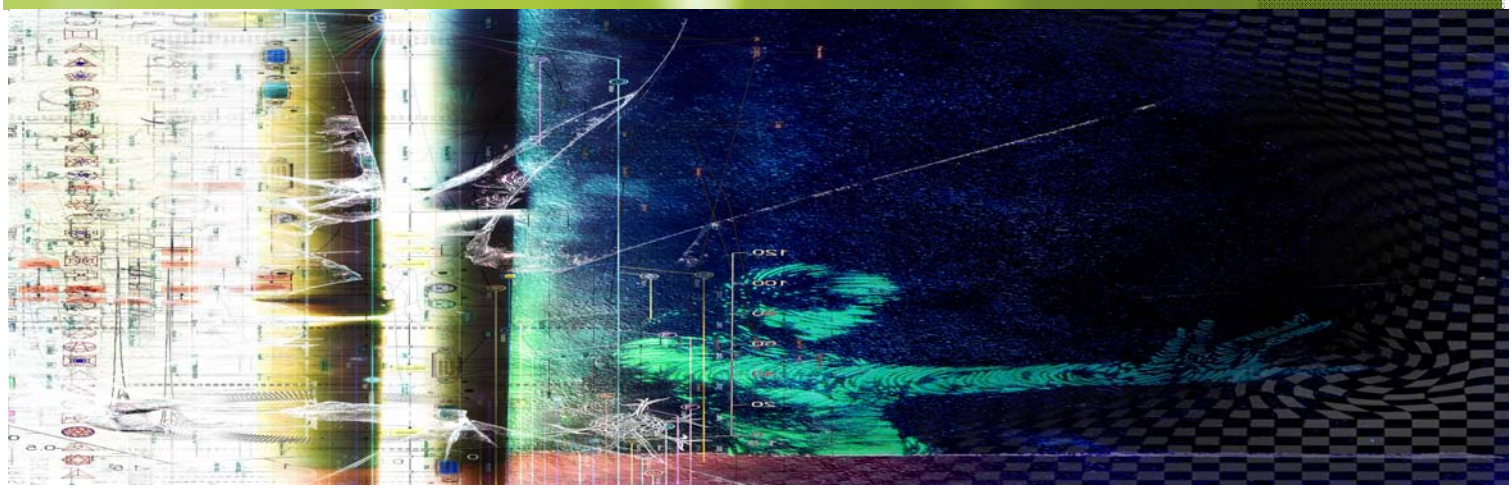
INNOVATION PROJECT

SWITCH-MODE POWER AMPLIFIERS FOR CURRENT CONTROLLED LOUDSPEAKERS

DTU: Arnold Knott

Pascal Audio: Jesper Lind Hansen

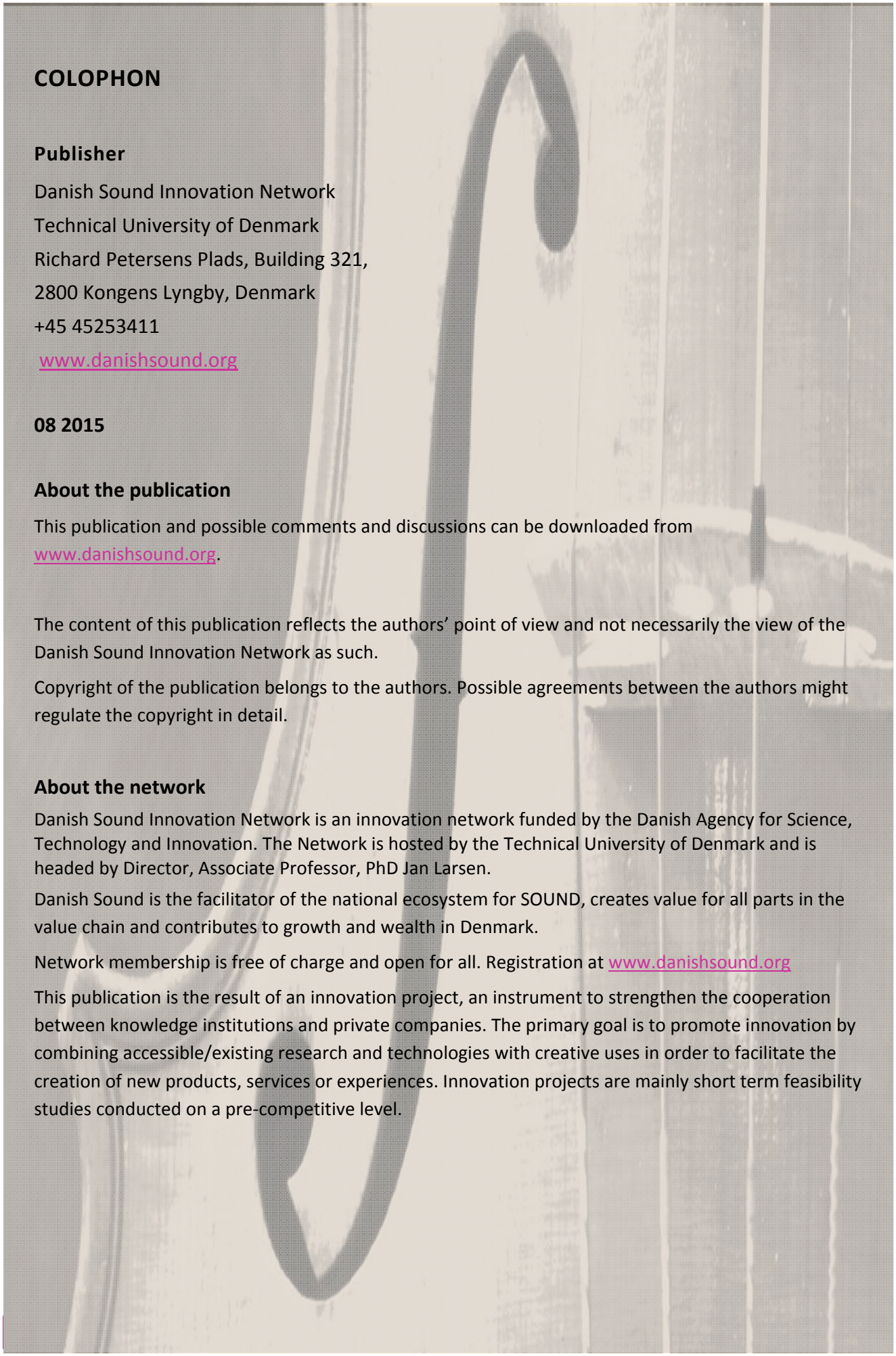
Loudsoft: Peter Larsen



Abstract:

In this project performed by Henrik Schneider, the concept of current controlled loudspeakers has been investigated in terms of distortion improvements. Other subjects such as motional feedback, tracking power supply and power requirements have also been covered. The combined work indicates that large sound system improvements are in reach by use of electrical means. Innovative solutions have been investigated and improvements of distortion, efficiency, size and cost as well as production have been demonstrated. A collaborative effort between the DTU and relevant audio companies has been initiated towards the implementation of these technologies.

DTU | PASCAL | LOUDSOFT



COLOPHON

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About the publication

This publication and possible comments and discussions can be downloaded from www.danishsound.org.

About the network

Danish Sound Innovation Network is an innovation network funded by the Danish Agency for Science, Technology and Innovation. The Network is hosted by the Technical University of Denmark and is headed by Director, Associate Professor, PhD Jan Larsen.

Danish Sound is the facilitator of the national ecosystem for SOUND, creates value for all parts in the value chain and contributes to growth and wealth in Denmark.

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This publication is the result of an innovation project, an instrument to strengthen the cooperation between knowledge institutions and private companies. The primary goal is to promote innovation by combining accessible/existing research and technologies with creative uses in order to facilitate the creation of new products, services or experiences. Innovation projects are mainly short term feasibility studies conducted on a pre-competitive level.

PREFACE

This publication is the result of an innovation project entitled “Switch-mode audio amplifiers for current driven loudspeakers”. The project is financed by the Danish Sound Innovation Network through a grant from the Danish Agency for Science, Technology and Innovation. The project is completed in the period 15/12-2011 – 22/3-20015 and managed by DTU, project manager Arnold Knott. Additional project participants are: Pascal Audio, Jesper Lind Hansen and Loudsoft, Peter Larsen.

SPECIAL CIRCUMSTANCES

If relevant, describe any special circumstances concerning the project’s start-up, development or completion.

INTRODUCTION

BACKGROUND

At the start of this project the loudspeaker was considered to be the weakest link in the audio chain when it came to efficiency and distortion performance. This was especially apparent for the vast growing market of pure performing microspeakers. A limited research was indicating that current controlled loudspeakers would be beneficial in terms of distortion and that created the main foundation for this PhD project.

OBJECTIVE

The main objective was to compare voltage and current driven loudspeakers in terms of distortion. Sub objectives were to figure out if other sound system improvements could be achieved through electrical means. Especially motional feedback and low impedance/high current loudspeakers were of interest.

IMPACT/EFFECT

The impact of the project is big since we have learned that many sound system improvements can be made by applying smart electronics. The research showed that a current controlled loudspeaker is not the best candidate for distortion reduction but motional control where feedback of the loudspeaker cone acceleration is used showed promising results. Furthermore motional control enables the design of non-linear loudspeakers that potentially offer a huge efficiency, size and weight improvement of a sound system. Such improvements will have a big impact on the growing market of mobile sound systems.

METHODS AND RESULTS

THEORY

Simplifications are often used in the design and testing of audio systems. Innovative results where however obtained by avoidance of those common simplifications. Real music signals where considered instead of a simple sine excitation and real loudspeakers characteristics were considered instead of a simple ohmic load. A big discovery was a power vs. time curve derived from a model that simulated a full sound system playing back more than 400 different music tracks. It was found that worst case peak power was needed for less than 100 ms which is a much shorter time frame than audio components are commonly designed for. This indicates that sound systems in general are over dimensioned.

EXPERIMENTS

Experiments include prototyping and testing of current controlled amplifiers, analogue and digital implementation of motional feedback, investigation of amplifier efficiency improvements using a tracking power supply concept, validation of power requirements for a 2 way loudspeaker.

RESULTS

The results are:

- In-depth analysis of current controlled loudspeakers [1]
- Evaluation of motional feedback and its possibilities [2]
- Novel power requirement modeling and validation [4,5]
- Investigation of tracking power supply and its effect on amplifier efficiency [3]
- Hybrid winding concept of toroidal inductors [6]

CONCLUSION

DTU will use the results of this project in future education, and student projects. Further more relevant audio companies have been contacted and funding applications for further research are in progress based on the ideas originating from this work. The collaborating companies ranges from big and acclaimed audio companies to small start-up companies. Several of the companies are cooperating with a knowledge institution for the first time.

Several of the concepts and ideas formed in this work are already inspiring new and innovative research by bachelor, Master students and PhD students. DTU has furthermore hired Henrik Schneider as a postdoc to strengthen the effort towards audio reseach. Several papers will be presented on the next AES conferences.

For Pascal audio and Loudsoft this project will hopefully result in new design software and services for loudspeaker design and more efficient, smaller and lighter amplifiers for professional audio.

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APPENDIX

Hybrid winding concept: