

# COMPACT LOUDSPEAKER ARRAY FOR ENHANCED STEREOHONIC SOUND REPRODUCTION

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## ABSTRACT

This paper illustrates the demonstration of sonic emotion 3D sound technology for compact loudspeaker arrays. The technology combines stereo/5.1 spatial analysis techniques with advanced sound field control techniques based on Wave Field Synthesis for optimum sound rendering of stereo/5.1 content within an extended listening area. sonic emotion offers a complete solution in the form of a chip that produces specific loudspeaker alimantation signals from stereo or 5.1 inputs. The SE-W58-II chip can be integrated into docking stations, compact IP radios, TVs, compact home theater systems, and soundbars for improved spatial sound rendering. Upcoming commercial products have entered mass production and will be available soon.

## 1. INTRODUCTION

There is a clear tendency for customers of consumer electronic products to hide audio and home entertainment devices as much as possible. All integrated sound solutions such as *iPod*<sup>TM</sup> / *iPhone*<sup>TM</sup> docking stations and sound bars are becoming increasingly popular but are still suffering from poor audio and spatial sound quality. The biggest problem is that all sound sources seem to originate from a small physical device at one unique position.

This paper presents sonic emotion 3D sound technology for enhanced stereo/5.1 reproduction with compact loudspeaker arrays. The solution is presented and compared with existing solutions of spatial sound enhancement. The technology is offered as a sound processing chip that can be integrated into consumer electronics (upcoming) products.

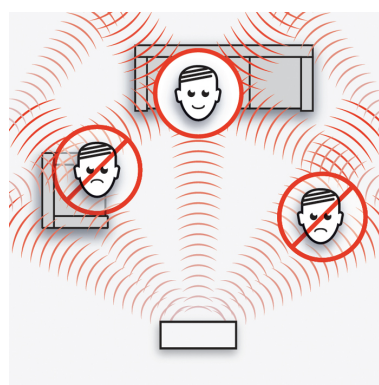
## 2. TECHNOLOGY

Technologies for sound spatialization using compact loudspeaker arrays make profit of either of the two following technologies:

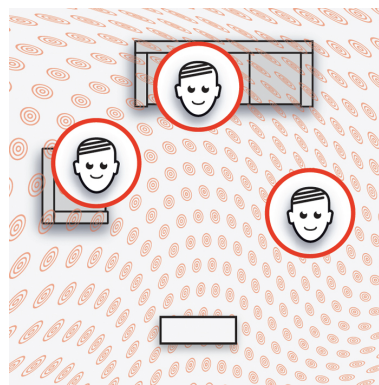
- transaural [1],
- beam forming using phase arrays [2],

Transaural technologies assume a very strict positioning and head orientation of the listener. If the listener moves or turns her/his head, the effect collapses and all sound sources seem again to originate from the loudspeaker array.

Beamforming technologies rely on sound beams that reflect off the walls of the listening room and create virtual loudspeakers.



(a) beamforming approach



(b) sonic emotion 3D sound technology

Figure 1: Example of placing multiple subfigures with simulation results.

These technologies therefore heavily depend on the reproduction environment and require complex calibration procedures. The effect is also very much position dependent, being only optimum at the calibration position. Another drawback of beamforming technologies is that they usually require a relatively high number of loudspeakers (20 to 40) and a corresponding number of amplifiers and D/A converters which raise the product cost considerably.

sonic emotion 3D sound technology relies on an enhanced implementation of Wave Field Synthesis [3] combined with advanced sound field control techniques and spatial analysis of

stereo/5.1 input signals. This approach enables to optimally control the sound field emitted by the loudspeaker array into the reproduction space using only 6 loudspeakers. As a result, spatial sound reproduction is mostly accurate at any listening position and in any listening room.

Two standard loudspeaker arrays have been defined for optimum reproduction:

- the *wavebar*<sup>TM</sup> that has the shape of sound bar comprising 4 loudspeakers in front of the device and 1 loudspeaker to each side plus an optional subwoofer,
- the *wave360*<sup>TM</sup> that comprises 6 loudspeakers arranged in a circular array plus an optional subwoofer.

The technology is extremely flexible and can be adapted to more complex shapes.

### 3. THE SE-W58-II CHIP

The SE-W58-II chip was developed in 2009 to integrate sonic emotion 3D sound technology into a packaged solution which can be easily integrated into consumer electronic products. The chip implements a product independent sound rendering algorithm. Custom filters are stored in a companion flash which is optimized for each specific product. The environment of the SE-

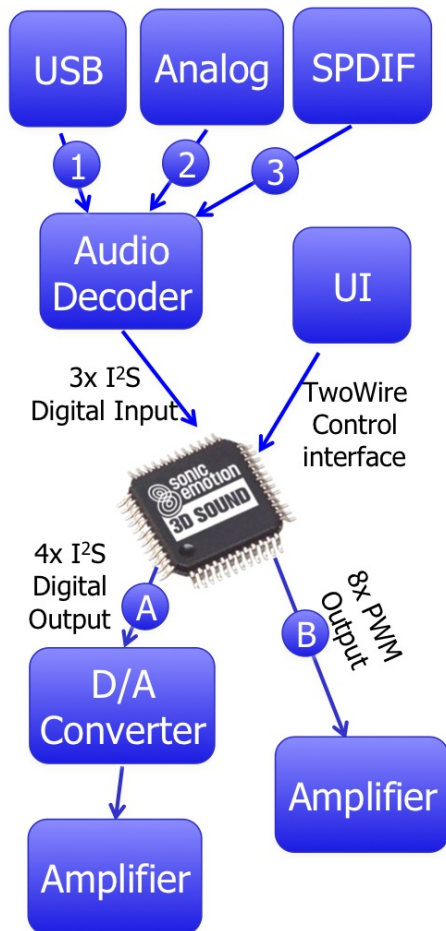


Figure 2: The SE-W58-II chip and its environment.



(a) Coby soundbar



(b) Scott Phuket

Figure 3: Example of placing multiple subfigures with simulation results.

W58-II chip is displayed in figure 2. The chip receives sound inputs from various formats which are converted into 3 standard  $I^2S$  stereo streams. The chip produces 8 sound outputs (6 loudspeakers + 2 subs) which take the form of an 8 channel PWM stream which can directly drive digital amplifiers or 4  $I^2S$  stereo streams which should be converted before driving analog amplifiers.

The chip is controlled using a standard TwoWire interface that allows to control user parameters (volume, ambiance, balance, clarity, ...).

### 4. UPCOMING PRODUCTS

First 3D sound products will be available in the coming months throughout the USA, Europe and Australia. Scott has already launched the Zurigo docking station and the Phuket home entertainment system - currently in mass production [4]. Coby Electronics also launched the first 3D-audio soundbar which will be available soon [5].

### 5. REFERENCES

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- [2] <http://www.cambridgemechatronics.com/sound.php>.
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- [4] [www.my-scott.com](http://www.my-scott.com).
- [5] [www.cobyusa.com](http://www.cobyusa.com).