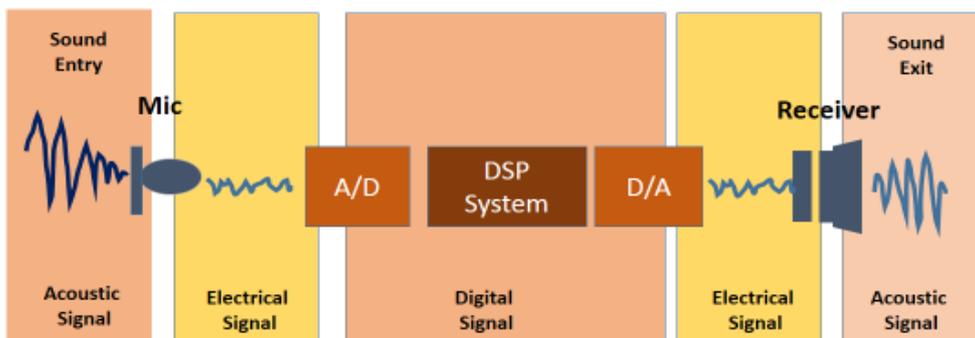


Imsys Lean Technology for Hearing Aid Solutions

Current and Future Challenges in Designing Hearing Aids

- Digital signal processing has revolutionized hearing aids in the last two decades. But DSPs (Digital Signal Processors) are efficient ONLY for what they are optimized for. Simple hearing aids are not programmable, and advanced ones may have an additional, different processor core for programmable control functions.
- There is growing need for energy-efficient, low-cost, small-footprint processors that can handle signal processing – both the basic functions and new options that become possible with increased programmability – as well as control functions, i.e. CPU tasks involving communication and control.
- Low-cost analog hearing aid solution suffer from:
 - Only offering basic hearing aid features
 - Limited possibilities to adjust to the needs of the user
 - Not evolving with Moore’s Law, and therefore now less competitive
- A major challenge is to best utilize the increasing density of IC technology in the best way, adding valuable new DSP and CPU functionality, and to make that fully programmable, allowing adaptation to different needs and future improvement. DSPs and CPUs are inefficient at performing each other’s tasks, because of fundamental differences in their optimizations.
- It can be summarized that the limitation with what hearing aids can do resides in the chip architecture, not in the knowledge of what can be done with them.
- There is potential for high growth in developing markets. Low cost and long battery life are important considerations here, but so is advanced functionality that allows adaptability to various needs without access to a highly trained audiologist.

Heading Aid Solutions: A Basic Principle



Processing signals from time-to-frequency domain and back, as shown above for a basic device.

- Sampling rate: 16 kHz (can be adjusted, but going higher is normally to no advantage for hearing-impaired persons).
- 128-point FFT-IFFT is used as the basis for the signal processing.
- With 16 kHz sampling this processing is done in a fraction of a ms, once every 8 ms.

The Imsys Lean Hearing Aid Solution

A working hearing aid solution on an Imsys IM3000 processor (180 nm process node):

- The entire DSP process, as well as needed control, is executed completely inside the Imsys patented processor core, which has the flexibility to be efficient with widely different kinds of operations and data formats.
- The IM3000 processor can complete the required signal processing in just 0.2 ms and just 0.1 ms for a 65 nm process node. Thus, less than 5% of the processor time is used for signal processing, meaning more than 95% is available for other tasks.
- The lean Imsys processor can therefore easily perform other tasks for a hearing aid device, which are more sophisticated than for traditional solutions. Such tasks include:
 - Monitoring user controls
 - Communicating with mobile devices
 - Communicating with a hearing aid device in the opposite ear
 - Adapting the parameters for the signal processing to individual needs and to the environment
- The IM3000 also has an analog-to-digital converter (ADC) on chip, which can be used with a basic electret microphone.
- In the 65 nm CMOS, Imsys can offer a complete digital solution with a much smaller silicon footprint, with simultaneous sophisticated functionality, since more than 95% of processor time is available for performing advanced functions. We can also add a power-management solution to further reduce power consumption.

The Imsys Advantage

The patented Imsys processor is an ideal hearing aid solution candidate for today – and for the future.

- Imsys' patented architecture: In addition to acting as a fast CPU, the smart functions of Imsys lean processor technology also act as an efficient DSP.
- Traditional DSP cores are good at signal processing, but are extremely inefficient in executing high-level language software. Imsys' lean processor technology is optimized for both signal processing and CPU-intensive control processing.

- Imsys patented architecture not only allows DSP routines (or parts of them) to be coded into special CPU instructions, they can also run autonomously in the background, interacting with software through interrupts and control blocks in memory. These processes can be invoked or synchronized by timers or I/O-units.
- Imsys core has a smaller footprint than industry-standard processor cores.
- Signal Processing Benchmarking – execution speed and power consumption:
FFT-computation benchmarking with a DSP chip from Microchip Technology Inc. (featuring a similar CMOS process as the Imsys processor), shows better results for the Imsys technology when it comes to execution speed, while consuming much less power. In fact, Imsys power consumption was 66% lower than the DSP chip.
- Code density:
Code density is important for high-level software, i.e. the CPU code, which tends to need a large part of the silicon area when integrated with the processor. The density of compiled Imsys CPU code is much higher than that of other CPUs. This means lower cost and/or more space for advanced software.
- Suitability for automation: Imsys' lean processor can handle automation efficiently:
Today's hearing aids have many features: directionality, noise reduction, etc., which can be turned on and off depending on the user's surroundings, with adjustments to the hearing aid settings. This kind of automation will continue to evolve.
- Suitability for machine learning:
The current generation of hearing aids lack learning capabilities – the ability to adjust to a user's needs over time in response to sensory information.
- One of the applications of a “machine learning” feature is the adjustment of various parameters to the needs of the user. Today this is done by an audiologist, and users may need to visit the audiologist many times. This process can be expensive, and inaccessible for some users. A hearing aid that can learn and adjust to the user's needs by itself would therefore be extremely valuable to many users.
- Imsys' processor architecture and instruction set is ideal for implementing machine learning systems (Please contact us for more details).
- Comparable in cost to analog hearing aid solutions:
Analog solutions offer only basic hearing aid functionality. An analog hearing aid is difficult to adjust to the individual needs of a user.
- Imsys offers a complete, future-ready digital solution, which is highly programmable, energy efficient, and offers rich functionalities including machine learning and advanced automation capabilities. Having a digital solution at the cost of an analog solution opens up large markets where there is a demand for smarter, yet basic hearing aid devices. Lean technology is therefore more value for money!

Learn More

Contact us to learn more about how Imsys can help you solve your challenge of designing better and futuristic hearing aid solution.