Mixed-signal and power: the next step forward

Julian Hayes, VP of Marketing and Applications,
Wolfson Microelectronics

Introduction

The pressure continues for designers of portable appliances to incorporate more high performance multimedia experiences into ever smaller products with longer battery life, and for these new products to be delivered to the market fast. Many new capabilities within these products, such as high-fidelity loudspeaker-generated sound, rely upon increasingly sophisticated mixed-signal ICs working at the boundary between digital electronics and the analogue real world.

Just as important as the digital and mixed-signal portions of today's portable designs are their power management functions, which enable products that deliver a rich consumer experience within power budgets that would have been thought impossible just a few years ago. No matter how big or small the application, no matter how great the silicon content, a battery-powered device needs power management. The battery itself needs to be charged and managed. And the appropriate linear or switching voltage regulators must be designed-in to produce and regulate the supply voltages required by the specific circuits, to an appropriate accuracy. Such functions, of course, are themselves inherently mixed-signal. Wolfson believes that increased integration of analogue and power-handling circuitry, and in particular audio, will be the most effective way to provide the next level of quality in user experience, as well as the next step in cost reduction and ease of design.

A larger share of the power budget

Today, mixed-signal and power management functions can represent a considerable proportion of the complexity – and the all-important power budget – of any system. This is a relatively new phenomenon. For example, three to four years ago, the CPU within a mobile phone might consume 250mW when active, with the audio portion of the design accounting for a mere 25mW. But, as digital circuits have moved to processes of 90nm and below, the CPU has become more power efficient. As a consequence, its power consumption today is often comparable to, or lower than, that of the audio subsystem. As a result, in the quest to reduce cost, size and in particular power consumption, the spotlight is now very much on the analogue and mixed-signal parts of the design.

Why not SoC? : Performance, price and time to market.

Historically, designers have had a straightforward solution to such challenges; integrate the errant functions into the ever-growing SoC. For digital functions at least, this generally produces immediate benefits, if only from the consequent reduction in external interconnections. This in turn leads to economies in the assembly process and increases in reliability. The accompanying reduction in size is also of benefit.

But the real gains from SoC integration have traditionally been even greater in successive generations of devices. Integrated functions join the rest of the SoC content on the established process shrink curve. Like the rest of the design, they get smaller, potentially faster and less power hungry each time a new process node is introduced.

In the case of audio and power management, however, there is good reason to believe that an alternative strategy will win the day. Rather than adding these two classes of function to the predominantly digital SoC, a better approach would be to integrate them together into a single companion chip, sitting alongside the SoC. To understand why that should be advantageous, it is necessary to look deeper into the specific challenges posed by taking the SoC route, and to examine some of the benefits to be gained by the alternative strategy of integrating power and audio.

Adding analogue (and by extension mixed-signal) circuits to a digital device has always been a tricky problem. Analogue designers inherently deal with "shades of grey". Certainly, they use the world's best-established simulator, SPICE, and this is based on accurate mathematical models of individual transistors. But characteristics such as noise, harmonic distortion and power efficiency are notoriously difficult to predict through simulations. In any case, analogue design is always about compromise (if only between cost and subjective quality), so a design typically requires iterative fine-tuning along the way.

Such a design style is an anathema to the SoC designer and not just because of the astronomical price of respinning a 65nm device simply to fine-tune the audio circuitry. More important is the opportunity cost of project delays, which, in an environment such as consumer electronics where product lifetimes are sometimes measured in weeks, are disastrous. All this risk, for the benefit of a marginal reduction in cost.

Mixed-signal integration

In contrast, combining power with audio makes sense in terms of design approach, allowing a more iterative design style to produce the best compromise between cost, power consumption and audio quality. Moreover, mixed-signal designers are well used to balancing the needs of digital and analogue on a single chip. Keeping these functions together provides a natural fit.

If power/audio integration makes sense when the functions are first brought together, an equally compelling case comes when considering the impact – or more precisely lack of impact – of process shrinks. The fact is that there is little or no inherent benefit in moving analogue circuitry to smaller geometries. In some cases the situation is quite the reverse.

Part of the problem is that, in a function like a headphone or speaker driver, the nature of the transducer has not – and will not – change significantly over time. The requirement therefore remains to deliver a certain amount of power into that same load. With the function essentially defined by an external component, process shrinks have limited impact.

But at a more fundamental level, the fact is that the optimal geometry for achieving analogue performance is never the same as the best choice to ensure low power, low cost and high performance in the digital domain. What mixed-signal and analogue require is the use of cost-optimised process platforms: which typically are two or three process nodes larger than the current digital "state-of-the-art".

When integrating functions on a 90nm wafer, for instance, analogue designers will typically need to draw their portions of the circuit at a larger geometry, such as 0.35µm. Because the cost-per-unit-area of a 90nm wafer is many times higher than that of a 0.35µm wafer, the proportional cost of adding the analogue functions is actually higher that it would be using a smaller process.

The integration of power and audio allows the use of a suitable cost-optimised approach. The system designer gets the benefits of integration and, once again, there are ancillary benefits. For instance, the dielectric breakdown voltages of the very smallest geometries are naturally lower than those of larger processes. The audio designer, therefore, also experiences less problems in implementing techniques such as direct battery connection, and generally in handling the higher voltages typically encountered in audio design.

No Compromise audio

Integrating power and audio also significantly enhances the designer's ability to provide "no-compromise audio". This is rooted in allowing a design style that is more sympathetic to an iterative, "fine-tuning" approach. It is also inherently tied up with audio's need for stable, high-quality power supplies to attain good performance - a need that an integrated system can more easily satisfy.

Performance benefits are also attainable because of optimisations at the circuit design level. As we have seen, mixed-signal designers are well used to dealing with the interaction between analogue and digital circuits.

Overall, an integrated system can guarantee both the subjective quality of the audio subsystem, and its performance in terms of measurable quantities such as power consumption. This ability is key in many consumer markets today, because the quality of the user experience is defined as much, if not more, by the quality of a device's interface to the analogue real world, as by its ability of its core processor to deal with the bits and bytes.

So, if the future really does lay in an integration of power and audio, what will the resulting devices look like, and what will determine their success?

Less external components

One key factor is likely to be manufacturers' ability to provide an integrated solution that requires few external components. Consequently, it will satisfy the need for miniaturisation in applications that are heavily space-constrained, whilst not compromising performance, in particular in the audio signal chain. Products will therefore need to be feature-rich, integrating the right mix of buck and boost DC/DC converters; LDOs; a battery charger; and power management/control circuits. A typical GPS or PMP design will also need ADCs for interfacing to real-world signals, such as battery temperature sensors and voltage monitoring circuits.

As well as providing an extensive feature set, such devices can be used to solve some especially tricky design problems. For instance, audio CODECs require a high-quality power supply. An integrated audio/power device will offer the two ready-integrated, with guaranteed performance.

Conclusions

It therefore seems likely that the next step along the road of semiconductor integration will not be tied to an expansion of SoC capabilities. Instead, it will fall to companies such as Wolfson, which have the required mixed-signal system design expertise and knowledge of how best to use cost-optimised processing technologies. Increased integration of analogue and power-handling circuitry, and in particular audio, will be the most effective way to provide the next level of quality in user experience, as well as the next step in cost reduction and ease of design.

CONTACT DETAILS:

HEADQUARTERS

Wolfson Microelectronics plc

26 Westfield Road
Edinburgh
EH11 2QB
United Kingdom
t: +44 (0)131 272 7000
f: +44 (0)131 272 7001
e:europe@wolfsonmicro.com

TAIWAN

Wolfson Microelectronics plc

2F, No.39, Alley 20, Lane 407,
Sec. 2 Tiding Boulevard,
NeiHu District, Taipei City 114,
Taiwan, R.O.C
t: +886 (0)8751 1600
f: +886 (0)8751 0201
e:asia@wolfsonmicro.com

KOREA

Wolfson Microelectronics plc

#502, Deokheung Building
1328-10, Seocho-Dong
Seocho Gu, Seoul 137-858
South Korea
t: +82 (0)2 584 3800
f: +82 (0)2 584 6336
e: korea@wolfsonmicro.com

JAPAN

Wolfson Microelectronics plc

6F Shinbashi
29 Mori Building
4-2-1 Shinbashi, Minato-ku
Tokyo 105-0004
Japan
t: +81 (0)3 5733 8677
f: +81 (0)3 3578 1488
e: japan@wolfsonmicro.com

Wolfson Microelectronics plc
6F Honmachi Executive Office
3-5-3 Minami-Honmachi
Chuo-ku
Osaka 541-0054
Japan
t: +81 (0)6 6281 6140
f: +81 (0)6 6281 6141
e: japan@wolfsonmicro.com

CHINA

Wolfson Microelectronics plc

Room 1911
Cyber Times Tower A,
Tianan Cyber Park
Futian District,
Shenzhen, China
t: +86 (0)755 8347 6775
f: +86 (0)755 8347 6785
e: china@wolfsonmicro.com

Wolfson Microelectronics plc
Unit E2, 8F
Zhao Fong Universe Building
No.1800 Zhongshan West Road
Shanghai
China
t: +86 (0)21 6440 0358
f: +86 (0)21 6440 0388
e: china@wolfsonmicro.com

USA

Wolfson Microelectronics Inc

16875 West Bernardo Drive
Suite 280, San Diego
CA 92127
USA
t: +1 (0)858 676 5090
f: +1 (0)858 676 0484
e: usa@wolfsonmicro.com

Wolfson Microelectronics Inc
245 First Street
Suite1800, Cambridge
MA 02142
USA
t: +1 (0)617 444 8492
f: +1 (0)617 444 8494
e: usa@wolfsonmicro.com

SINGAPORE

Wolfson Microelectronics Pte Ltd
101 Thomson Road
United Square
#05-02
Singapore 307591
t: +65 6356 6006
f: +65 6356 6116
e: singapore@wolfsonmicro.com

INDIA

Wolfson Microelectronics plc
Bangalore
t: +91 802 365 3406
e: india@wolfsonmicro.com