

# PowerWise® Solutions and the Future of Energy Utilization

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## Introduction

Today's technological civilization is driven by energy – whether stored or captured, it is required to run our machines. Without energy and the proper method to convert it into useful power, much of our technological world would stop working. In 1908 William A. Smith stated, “Engineering is the science of economy, of conserving the energy, kinetic and potential, provided and stored up by nature for the use of man. *It is the business of engineering to utilize this energy to the best advantage, so that there may be the least possible waste.*”

It was noted even in the early part of the 20<sup>th</sup> century that it was good engineering practice to be conservative with the available resources. Today, it has become a requirement. In electronic design, power is a finite commodity. Additionally, much of the power that runs electronics ends up as wasted heat which provides no useful work. Think of the engines of the Internet and cellular infrastructure. A large blade server farm can house over 10,000 computers each using roughly 200 watts of power, not to mention the air conditioning required to pump the excess heat out of the buildings. Add the future requirements for streaming video and the power numbers sky rocket. This pattern of increasing power consumption will only continue as more countries add capability for their populations.

With this trend in mind, National Semiconductor has continuously developed products that provide a level of performance at reduced power consumption. This is the PowerWise brand – products that have exceptional performance-to-power ratios. PowerWise components can be found in every National product family from interface products to high-speed data converters, from communication devices to power regulators. What qualifies National's devices to be PowerWise components? Let's start by evaluating the metrics.

## The Performance-to-Power Ratio

A simple metric for an automobile is the miles per gallon (MPG) or kilometer per liter (KPL) rating. As the cost of gasoline (our current infrastructure portable energy storage

medium) rises, this metric becomes more important. This is the same concept as the performance-to-power ratio. This can mean two things to an engineer – *lower power consumption and excess heat generated, or higher performance at the same power consumed.*

The obvious advantage of lower power is higher economy (less dollars spent on energy) or longer battery life (i.e., play time on a portable music player). A not so obvious advantage is longer service life from reduced heat wear on the electronics from semiconductor fatigue in the presence of elevated temperatures. The lower the ambient temperature, the longer service life a product or system will provide. This can also lead to reduced cost due to longer replacement periods.

In other cases, a new design may need to be implemented with the previous resources (space, power, waste heat limits, etc). A classic example could be a cable set-top box (STB). The physical space is either the same or smaller than the previous model, the power (which directly relates to the waste heat) is either the same or lower, however the design requirements probably specify a higher level of performance (i.e. a classic standard definition STB now moving to HDTV and adding DVR capability). This design change is a challenge in that the resources have not changed – the power and physical space remain the same. If the designer is going to succeed, then higher performance components that use the same or less energy will be required. This is the advantage of increasing the performance-to-power ratio.

## Architecture Versus Process

National has understood for many years the importance of process technology – not only for consistent high quality, but also for higher performance at lower power. National was a pioneer with the industry's first CMOS operational amplifier as well as the architects of Low Voltage Differential Signaling (LVDS) communication devices and Low Dropout Regulator (LDO). High bandwidth, low leakage processes are essential to providing great overall performance in semiconductors. But that is only half of the story.





Building on the knowledge gained from helping customers create high performance analog systems, National is providing a library of reference designs that illustrate the best system performance. An example is the latest addition to this library – the ADC083000 reference design which not only implements a complete instrumentation (i.e., Oscilloscope, Automatic Test Equipment etc.) analog front end (AFE), but also uses the new PowerWise LMH6555 1.2 GHz differential driver as part of the signal chain. This component in combination with our PowerWise ultra-high-speed ADC083000 data converter and timing solutions provides a great starting place for engineers involved in designing instrumentation.

## The Future From Email to Streaming Video

For a good example of why energy efficiency is important, let's examine a phenomenon to which most can relate. In the early days, the Internet (circa 1990) was used to move small files and mostly emails. Emails of the day only contained text and HTTP was just beginning to be used to support HTML encoded rich content. As the World Wide Web emerged and e-commerce began, the Internet was moving a much larger amount of data traffic including photos and extremely rich content. Once a simple method was found to compress audio (MPEG 1 Layer 3 or MP3), audio was being shipped around as well, absorbing the available bandwidth and driving consumers to find faster connections to the Internet.

Today we see the emergence of a new breed of bandwidth draining content called streaming video. Recent data released by Ellacoya Networks in June, 2007 showed that YouTube accounted for 20% of HTTP traffic or nearly 10% of all Internet traffic. This is the first time that HTTP based traffic has exceeded Peer-to-Peer (P2P)

applications such as email. As consumers demand more video over IP networks, it won't only affect the infrastructure, but also the end devices. Mobile video streaming is very demanding and requires not only decompression, but high quality audio. Add in local compression for sending video in real time (now appearing on many handsets), then power is once again being consumed for additional features.

In the not-to-distant future, streams of video with audio will be the normal traffic found on the Internet. Most handheld portable devices will support video recording and playback as well as real-time streaming which will also require low-latency and high-bandwidth availability. All of these features require large increases in infrastructure as well as local processing power. This is why the performance-to-power ratio is so important to design.

## Conclusion

As the market forces drive the adoption of streaming video, instant bandwidth, and unlimited storage capacity, the resources required to fuel it all remain finite. According to the US Department of Transportation, in the 1970's automobiles on US highways only averaged 12 MPG, today's vehicles can easily reach 30 MPG on the same fuel used 35 years ago. Additionally, high-performance "muscle cars" of today can easily boast 500 HP and still achieve reasonable mileage. This is what increasing the performance-to-power ratio can achieve. The same gains can be made in electronic devices, and National's PowerWise product family of products enable this performance increase in systems from the processor core through the the signal path.

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