

Application Segment Overview – Digital Power Management and Control

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Introduction

Digital power management and control is one of the most discussed topics among designers and end users in the power supply industry. The slowdown in new topologies and innovative analogue control techniques left the industry with very little excitement except perhaps the emergence of assorted flavour flavours and various levels of digital management and control implementations. Adoption rate is still modest considering the total available market for both power supplies and power management and control devices but a few new and some existing application segments start to appear as early adopters of the technology. In these areas, communication, system management and in most cases the actual loop control has been steadily migrating towards digital implementations lately with more the 50% of new designs now committed to utilize digital control techniques. As the rest of the industry capitalizes on the lessons learned from the daring endeavours of the “digital pioneers”, more variety and better suited circuit components and wider adoption of digital power management and control are expected. Consequently, digital power supplies and devices used for digital power management and control will enjoy an above average growth and market penetration in the coming years.

Key Market Drivers

System level communication for identification, configuration, control and monitoring of the different elements of the power system are the key drivers for digital technology in power supplies. Based on these new capabilities, intelligent systems can be built to manage power delivery based on activity levels and power demand, ultimately optimizing efficiency and reducing operating cost. The most important differentiation provided by the digital technology is to achieve best possible efficiency under wide operating conditions. To attain this goal, the power supply must be fully integrated into the system through communication and remote telemetry. Furthermore, advanced control algorithms need to be implemented on the converter level as well. The complexity of the required methods usually points beyond the capabilities of traditional analogue techniques opening the door for digital implementations.

Answering the slowly but noticeably increasing demand for digital features in the entire power conversion area, device manufacturers start offering a larger assortment of digital controllers. The new devices are fine tuned for and specifically target power conversion applications at vastly different price points. In addition to general purpose programmable devices such as DSPs and microcontrollers, application specific digital controllers dedicated to a single topology are also offered. For instance digital controllers with communication capability for synchronous buck converters are finding traction in the industry. Further examples can be found for simple, low pin count digital controllers for PFC and flyback applications with a target price close to the cost of their analogue counterparts. Ultimately, the larger selection and more suitable device offering could turn into a key driver to proliferate digital technology in power supplies.

From the application point of view, new power conversion opportunities had emerged with complex control needs which are perfect match for digital control. Examples include applications in the renewable energy field especially photovoltaic inverters where digital technology is used in the majority of the power supplies. From the list of more traditional applications, high performance point-of-load converters, high end, multi stage power converters in telecommunication systems from base stations to central offices, and similar applications in data centres commonly employ digital communication and digital control techniques in the latest designs. These applications are the first frontiers for digital power because of the extreme technical challenge to meet regulation requirements or due to their specific usage profile. The long lifecycle, 24/7 operation of these installations present the most benefits in overall energy usage provided by the efficiency gains realized in power conversion and on the system level. These applications are also the best opportunities to recover the cost of introducing the new technology in the design and manufacturing environment at the power supply manufacturers.

In the past few years murky visibility in the intellectual property war surrounding digital communication and control in power supplies and power systems presented a road block to many companies. Uncertainty in the risks and financial consequences of using simple, digital hardware layer and software protocol between power supplies made most but the largest power supply manufacturers sit on the sideline and wait. As the IP situation solidifies and communication standards are being established and followed by major power supply manufacturers a critical obstacle will be removed from the path of proliferation of digital technology.

Key Metrics

Digital technology needs to deliver on its promise of flexibility and faster time to market potential. It is desirable that flexibility could be delivered without the need for the power supply designers becoming experts in firmware programming, optimization and verification. Therefore, it is understood that easy to use design software and development tools based on user friendly graphical user interface (GUI) are needed to support the new technology. Since the learning curve is rather steep to enter digital control and digital power management, significant help is solicited from device manufacturers to bridge the knowledge gap between traditional analogue design practices and the new digital approach.

At the same time, easy implementation of differentiating intellectual properties, the unique knowledge and design practices accumulated at the power supply manufacturers must be ensured. This requires personalization of the behaviour of the system and/or the operation of the power supply. These characteristics now reside in the code executed by digital devices and by definition they necessitate some level of programming by the power supply designer or system architect.

To take a bigger hold on new designs digital technology must also prove the perceived reliability benefits compared to its analogue counterparts. While lower component count, software calibration capability and significantly reduced aging effects of digital implementations all point towards higher reliability, due to relatively short history and limited field data, long term reliability and the expected lifetime of digital implementations are often questioned by the end users and power supply manufacturers as well. The effects of noisy environment, magnetic interference and high temperature in power supplies represent a new challenge for signal integrity in low voltage digital circuits and for data retention in memories, a

critical building block for all digital technology. Software reliability is another topic generating heated discussions among designers and users of digital power supplies.

The superiority of digital loop control over analogue techniques is already proven. Digital controllers can achieve high frequency operation, excellent time domain resolution and better than analogue transient performance in demanding applications. With the right amount of computing capabilities component tolerances and aging effects can be addressed using calibrations and advanced digital algorithms such as auto-tuning of the voltage regulation loop. The continuously toughening stand-by energy consumption and light load efficiency regulations can be met by easily changing the operating mode of the power supply – an easy task using digital control.

Trends

In high power, long life applications where the biggest efficiency gain can be demonstrated and the most reduction in total cost of ownership can be shown, digital power will continue to enjoy a modestly growing market share. Acceptance and even end customer pull to accelerate digital implementations might happen as focused efforts might result in advances to figure out what to do with all the data collected through digital telemetry. Examples of these directions are to use digital power management capabilities to prevent downtime, failure prediction, cost optimize redundancy, etc.

In addition, adoption of digital management and control for lower end applications is gaining attention. The momentum is building to strike the right balance between high cost, flexible, fully programmable solutions and more specialized, targeted devices with narrower application area. The battle between application specific and general purpose digital controllers will intensify as the selection between useful, necessary functions and nice to have digital functions will be clarified by the market. This trend will facilitate the introduction of new devices, further price optimization of components and systems architectures using digital technology for management and control function.

Communication will be more wide spread in larger systems. At the same time, simplification and standardization of digital communication need to continue in the coming years. Ultimately, the power delivery, protection and configuration subsystems will be more and more integrated into the – local or remote – supervision on the equipment or even installation level. Board mounted and embedded power supplies will also benefit from communication capabilities to offer more sophisticated functionalities and to increase overall performance.

Challenges

The most pressing challenges for digital power management and control can be categorized in four major areas:

- Improve the price-to-performance ratio of digital implementations and push the price parity point to lower functionality levels to open cost sensitive, high volume applications for digital power management and control algorithms.
- Show consistent efficiency and performance benefits over analogue solutions and reduce power consumption which is essential to enter the mainly battery powered mobile market place.

- Ensure interoperability among systems and power supplies using digital technology.
- There is still much to do to clarify how to implement digital know-how in future power systems and what are the right expectations from the technology. Education at all levels must continue to be able to accurately assess the merit of digital approaches in the immensely diversified application space.

It is expected that the power supply industry will address and overcome these challenges in the coming years as digital technology will keep proliferating across many application areas.