Digital Power System Management Products Quicken System Deployment & Minimize Operating Cost, Enabling Predictive Analytics & Smarter Energy Management

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A key challenge is to reduce power consumption by understanding its precise usage from a broad range to detailed board level; For example, from large scale server farms down to small scale board-mount power in each rack mount system. Managing power and implementing flexibility in a high rail count circuit board can be very difficult and requires engineering hands-on probing with DVMs and oscilloscopes, which often require rework of PCB components. To simplify these tasks of managing power, there is a growing trend to configure and monitor power over a digital communications bus. In other words, it implements the telemetry capability to set, monitor, change and log power parameters. This technique is frequently referred to as "Digital Power" or "Power System Management" and enables system designers to simplify and accelerate system characterization and optimization during prototyping, deployment and field operation.

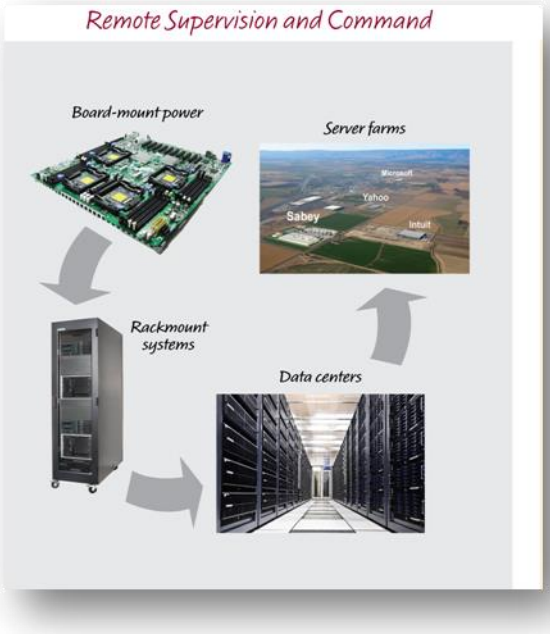


Figure 1. A more accurate energy and operating cost management of any scale system is possible with digital power system management device, featuring digital bus telemetry, onboard memory and software control.

Digital Power System Management: Accessing, Monitoring & Changing Critical Power Parameters via a Digital Bus Interface

Digital power system management (DPSM) products are configured and monitored via a 2-wire PMBus interface, an open I²C-based digital interface protocol. This enables seamless integration with existing embedded systems and architectures, board mount controllers (BMCs) and intelligent platform management interface (IPMI) functions. For simplicity and ease of use, especially at the earliest stages of hardware development and testing, a graphical user interface (GUI) running on a PC is used for communication with a DPSM device through a USB-to-PMBus adapter board. The block diagram in Figure 2 shows a typical way to control eight point-of-load (POL) regulators with DPSM. It includes several POL regulators, a DPSM block, digital bus and a host to collect and transfer data.

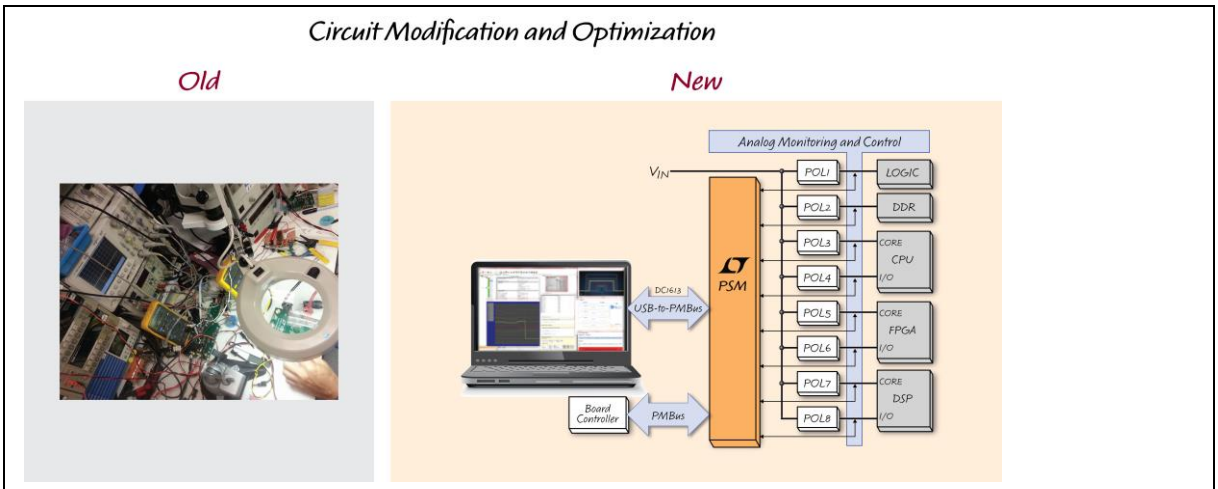


Figure 2. Digital power system management devices with digital telemetry allow on-the-fly parameter changes, eliminating hardware alterations.

DPSM products can provide the user with critical power related data: one can access load current, input current, output voltages, compute power consumption, efficiency, and access other power management parameters via a digital bus. This provides the ability to develop predictive analytics, minimize operating cost, increased reliability and for smart energy management decisions to be made.

Benefits of DPSM: Voltage Optimization Increases Performance of ASICs, FPGAs & Processors

Output voltage accuracy of a POL regulator is critical in powering low voltage devices such as ASICs and FPGAs. A DPSM device is constantly measuring the power supply output voltage with a very accurate and stable Analog-to-Digital Converter (ADC). A time servo loop automatically adjusts the value of a trim DAC, which cancels the power supply output voltage drift and greatly improves precision. On the other hand, the traditional power supply's output voltage drifts with time due to temperature variations and manufacturing tolerances. These voltage drifts may violate design margins. The output voltage, sequencing arrangement, voltage and current supervisory thresholds are only adjustable by PCB or component change.

Figures 3 and 4 summarize these benefits, comparing traditional POL converters (left) with DPSM products (right).

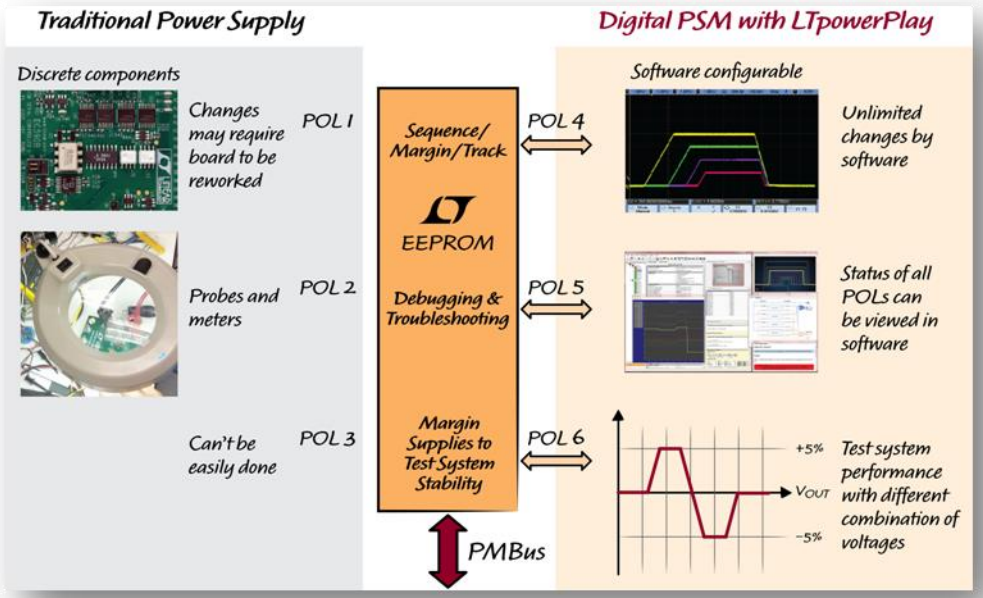


Figure 3. A DPSM device is constantly measuring the power supply output voltage with a very accurate and stable ADC. A simple GUI such as LTpowerPlay™ enables READ/WRITE of power parameters.

Benefits of PSM: Dynamic Control of Power Parameters Lowers Energy Consumption

The traditional supply voltage is fixed and can't be easily changed on the fly. A digitally managed supply, on the other hand, is adjustable via an industry standard, two wire digital interface, some with better than 1mV of resolution. With a DPSM product, one can fine tune system performance and minimize wasted power, enabling techniques such as dynamic voltage and frequency scaling, which have been demonstrated to reduce overall system energy consumption.

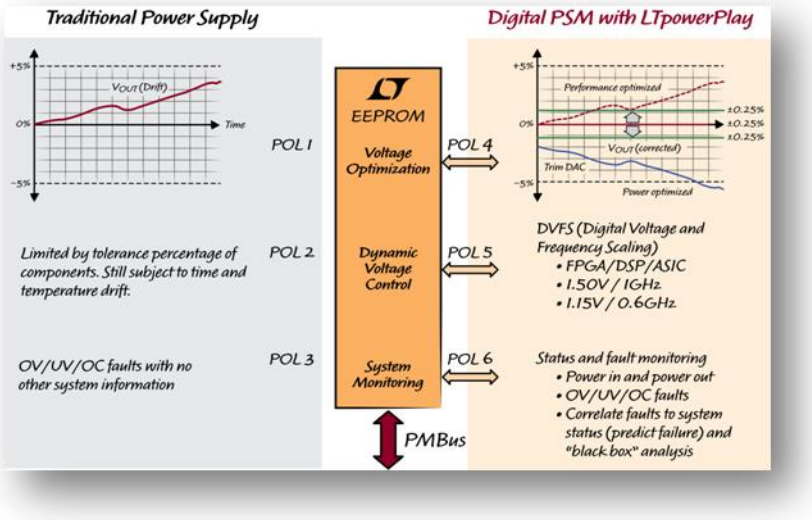


Figure 4. A DPSM product can easily be configured to fine tune system performance via a simple GUI such as LTpowerPlay to minimize wasting power by enabling techniques such as dynamic voltage and frequency scaling.

Benefits of PSM: Telemetry & Onboard Non-Volatile Memory Enable Seamless, Precise System Monitoring, Protection & Data Logging

In traditional power supplies, some sophisticated system monitoring function are usually separate from the DC/DC regulator, requiring additional supervisory ICs or circuits. Moreover, onboard features such as overvoltage (OV), undervoltage (UV) and overcurrent (OC) faults can be detected, but not all are reported to a host controller, at least not in a simple and seamless method.

In the digitally managed regulator, power monitoring functions are built-in and are programmable. Fault conditions for one POL can be easily combined with other POLs to create a customized response to a variety of fault conditions.

With a DPSM device, detected faults are correlated with high accuracy measurements of voltage, current and temperature. Internal non-volatile memory can store the information useful for debugging and root cause analysis.

Another topic of interest is the exact sequencing arrangement of a system's voltage rails, which is often unknown until after board fabrication and then supply ramp rates may need to be adjusted. Sequencing and ramping in a traditional power supply can be done, but the values will be static, adjusted with a board level change. With regulators equipped with DPSM capability, power parameters are software configurable. Board level or component level changes are not required. Power parameter corrections can be done in the chamber, eliminating another requalification and delay in product launch.

One obvious advantage is faster and simpler debugging and troubleshooting. With a traditional power supply design this is done with external meters and probes which introduce measurement difficulties. With a digitally managed power supply the test hardware is built-in to each POL and measurements can be read over the digital interface with a GUI.

The last example is margin testing. Margin testing is the practice of exceeding the limits of the power supply to simulate the worst case performance. Margin testing is the only acceptable alternative to worst case analysis, which is very costly and time consuming.

Building margin testing into traditional POL increases complexity and are inaccurate due to manufacturing tolerances. In a DPSM product margin testing is built-in and is very accurate. Moreover, because each POL can have its own margin levels (both high and low) complex patterns of power supply levels can be programmed over the digital interface. This provides a fast and easy way to achieve worst case analysis of system level performance.

Take Control of Your Power: Dual 13A µModule Regulator with DPSM

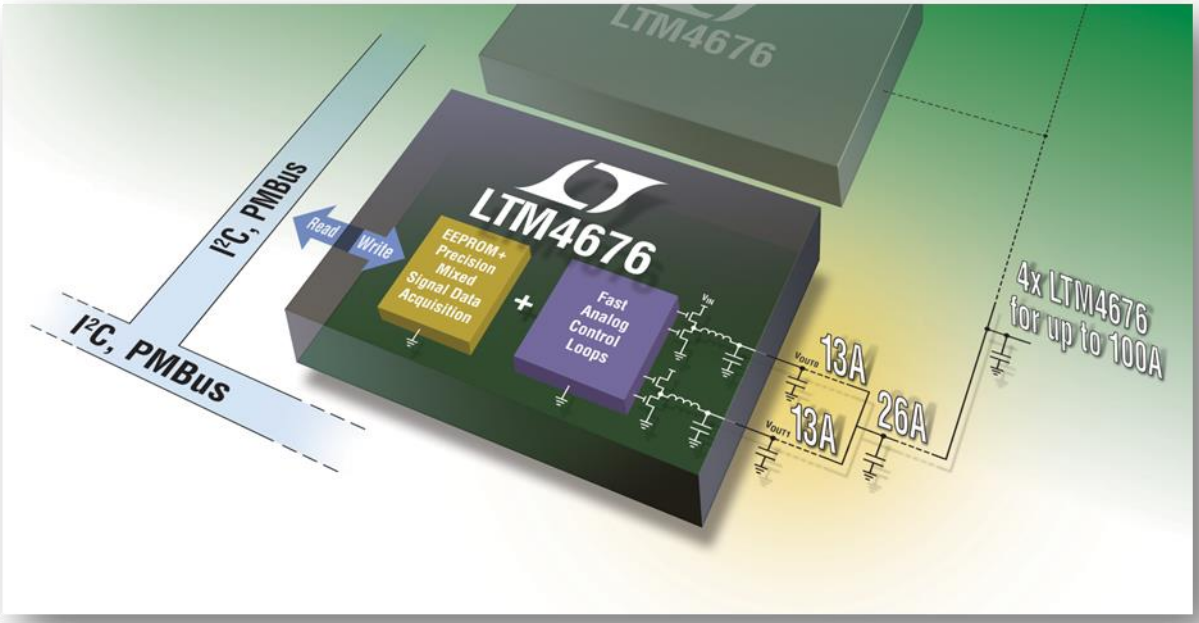
The new family added to DPSM family, is a µModule® (micromodule) power product with PSM. A µModule regulator includes the inductors, power MOSFETs and the compensation circuitry, shown on the bottom of Figure 5. The LTM4676 is the first uModule product belonging to this family.

In addition to delivering power to one or two points-of-load, the LTM4676 features configurability and telemetry monitoring of power and power management parameters over PMBus, an open standard I^2C-based digital serial interface protocol. The LTM4676's 2-wire serial interface allows outputs to be margined, tuned and ramped up and down at programmable slew rates with sequencing delay times. The LTM4676 has a built-in 16-bit ADC and I^2C-based interface that lets you read back input and output currents and voltages, output power, temperatures, and uptime. Some peak values are readable. The output voltage is regulated at the point-of-sense to better than ±1% over temperature, line and load conditions. Check with the factory for even tighter options.

Specified output current readback is ±2.5% at 10A load. This accuracy enables excellent characterization and monitoring of ASIC, FPGA, and CPU/GPU power consumption. Combined with the ability to fine-tune output voltage on-the-fly, the LTM4676 opens the door to implement dynamic voltage scaling, load shedding, and other schemes to get the most out of your system, according to the power management goals you set.

With the LTM4676, digital monitoring of all the rails in a system is possible and easy to implement. Digital monitoring yields detailed insight into energy consumption, patterns of loading and long-term trends. This data provides us an opportunity to develop predictive analytics and make informed decisions about scheduling preventative maintenance.

A fault-log feature enables retrieving of data recorded by the LTM4676 device in the moments leading up to a system shutdown event. This can shed hours or days from diagnosing a problem in high-end systems. And correcting the issue can be as simple as changing some register settings over a PC. Furthermore, field monitoring and upgrades to the system's power supplies can be realized.



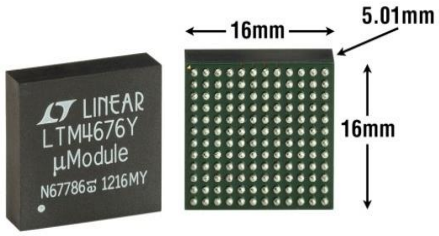


Figure 5. The LTM4676 is dual 13A or single 26A µModule regulator with DPSM capability. It is housed in a 16mm x16mm x 5.01mm BGA package, simplifying both DC/DC circuit design and digital telemetry.

Summary

The LTM4676 µModule regulator, featuring digital telemetry and digital power system management, enables systems designers to simplify and accelerate system characterization and optimization during prototyping, deployment and field operation. With superior parametric precision in WRITING and
READING power parameters, the device is optimized for use with very low voltage, high power IC such as ASICs, FPGAs and processors. Take control of your system's power with the LTM4676.