How to select digital power ICs

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The momentum behind digital power in all of its shapes and flavors continues to accelerate as engineers become more familiar with the technology and realize its many benefits.

Power system and power supply designers have found that deploying digital power need not be a revolutionary transition to radically new design practices. Because of the variety and range of digital power devices now available, designers can capitalize on its considerable advantages at a pace that makes sense for any particular design project. The benefits are valuable and plentiful.

Overview of digital power

Size and Cost

Digital power takes advantage of the evolution of mixed signal process development. Mixed signal processing accommodates both digital circuits circuits and analog circuits. The digital circuits can range from microprocessors to state machines to communication peripherals to simple logic. Memory is also included in this partition. The analog circuits can include operational amplifiers and comparators, analog-to-digital converters (ADCs), digital-toanalog converters (DACs) pulse-width modulator (PWM) generators and references, and more. Taking advantage of this process technology allows these devices to optimize the portioning of the analog and digital circuits while integrating it all onto one chip. This reduces the number of devices and simplifies the printed circuit board design. By reducing the bill of materials (BOM) and device count, system costs are brought down while reliability increases because the system comprises fewer interconnected components. Since one controller may serve many solutions, there are fewer stock keeping units (SKUs) for manufacturers to track and stock.

For example, integrating a versatile microcontroller (MCU) can perform a range of power-related functions and eliminate the need for another discrete controller chip. An integrated MCU can be programmed for many power management features, such as overvoltage, undervoltage, overcurrent conditions and others. Depending on the capabilities of the digital MCU, digital power devices can be programmed to include a variety of power conversion features such as simple to complex topology support, adaptive loop compensation, slope compensation for peak current mode control, current sharing and temperature compensation. Another example is providing power factor correction (PFC) while also performing an e-metering function that is accurate to within 1 percent without an external metering device.

By providing a range of digital power devices, the designer can choose the functionality that best fits their application without the burden of unused capabilities.

Power Topology Flexibility

The flexibility inherent in digital technology allows a digital power device featuring an integrated digital MCU or configurable state machine to serve as a platform supporting all of the major traditional power topologies, as well as any new and more sophisticated topologies that might emerge. A sample of the supported topologies would include phase shifted full bridge, multiphase interleaved PFC, bridgeless PFC, resonant LLC, bi-directional DC/DC, bidirectional DC/AC and PFC, three-phase

inverters, maximum power point tracking (MPPT) DC/DC and others. Because of this flexibility and integrated peripherals, digital power devices are able to provide precise waveform control by using high-resolution phase, frequency and duty cycle control algorithms.

Efficiency

Advanced control algorithms allow digital power devices to enhance the power efficiency of power supplies and systems, reducing the power consumed by the supply and the host system. This could dramatically affect the operating costs of many applications, such as data centers, storage farms and others. Adaptable digital control can quickly adjust to changing line and load conditions and thereby optimize both power and system efficiencies. For example, the control method of the power stage could be altered in real time for more efficient power transfer, or the power conversion might be adjusted to reduce its power consumption during light or no load conditions.

Reliability and Safety

The ease with which digital power devices are able to interact with other digital and analog components in the system means that they can effectively enhance the reliability and safety of the host system by performing system-level monitoring and fault response. In fact, the programmable nature of digital controllers lets them support multi protocol communications over a variety of buses such as PMBus, I2C, SCI, SPI, CAN and others so that the system can easily communicate with the power subsystem. By monitoring and logging data throughout the system, digital power technology can contribute to system diagnostics to give early warning of faults and failures so that the system can take the appropriate action.

Wide Band Gap (WBG) Compatibility

Rather than wait on new analog controllers to be developed that can address the new capabilities

of WBG devices, some digital power solutions can be used today. Combining digital power's ability to support practically any power topology while providing very high-resolution timing control, new devices like gallium nitride (GaN) can be used in advanced topologies with higher switching frequencies, lower switching losses, greater power density and zero reverse recovery.

TI's Digital Power Innovation

The portfolio of digital power technology from Texas Instruments (TI) is by far the most comprehensive in the industry. While other vendors may provide specialized digital power solutions for one or a few segments of the industry, TI's broad array of digital power innovations can meet practically every conceivable design need.

Generally speaking, digital power technology is deployed in a broad spectrum of applications, from relatively simple functionality to the most complex power management tasks. The digital power marketplace is typically subdivided into four different types of devices, each with its own set of strengths and solutions. They are:

- Digital power controllers.
- Analog power regulators with digital interfaces.
- Digital power sequencers.
- Digital hot swap controllers.

The remainder of this white paper explains each of these categories and mentions some of the devices from TI's digital power portfolio.

Digital Power Controllers

Digital power controllers regulate the output of different types of power supplies, ranging from AC/ DC to DC/AC supplies, isolated DC/DC, point-ofload (POL) regulators, power conditioners and filters, and others. Because of their integrated MCU and power specific peripherals, digital power controllers have the required computational capabilities for simultaneously performing loop compensation and managing the feedback loops to maintain the proper output regulation or conditioning, as well as the ability to perform other system-level monitoring and regulating tasks. These devices are equipped with peripherals optimized for power management applications.

TI's digital power controllers feature a number of capabilities that are unique in the industry. For example, their high-frequency and high-resolution operations make them compatible with GaN technologies, providing high switching speeds and low power losses. In addition, all of TI's digital power controllers feature excellent transient response and dynamic performance. These capabilities are delivered using various technologies. In some cases, the digital power controller is designed for extremely fast interrupts, which reduce latency between sampling and calculating the response for the control loop. In other cases, a peripheral is used that integrates a dedicated ADC and calculation engine to provide a fast response for the control loop. Often, these rapid response capabilities make it possible for the controller to reduce the impact of variances in power stage components.

The programmability of the MCU integrated into TI's digital power controllers makes them fully configurable and able to control complex topologies and modes of operation like bidirectional, multiphase re-ordering and alignment, adaptive dead-time control, and others. Moreover, these controllers can be configured to support system-level monitoring, instrumentation and communications over a variety of buses, including PMBus. This allows sophisticated power management processes like online diagnostics and reporting, the collecting of field power consumption data to optimize designs, and the programming of new parameters into the controller via a digital interface. As a result of this, a wide variety of methodologies can be adopted for the monitoring of the control loops. In fact, implementing the control loops with external components can be

avoided entirely through the controller's digital compensation. The monitoring and data logging performed by the controller can also form the basis for early fault warnings, which in turn allow the system to take actions that reduce the impact of these failures.

C2000[™] Microcontrollers

Design flexibility and ease of development make TI's C2000 MCUs the centerpiece of many power system designs across a broad range of applications. With full programmability in highlevel C and easily altered configuration variables, C2000 MCUs have shown that they can form the basis for many platform architectures that can be easily adjusted to meet the needs of a specific design case, including the most advanced power topologies. The combination of highly configurable PWMs and ADCs allow C2000 MCUs to support the most sophisticated power control capabilities. The availability of modular software libraries in C accelerates the intuitive development of systemlevel applications.

TI's C2000 real-time C28x processing cores pack processing power speeds up to 200 MHz to support the most sophisticated power systems. In addition to its main processing core, C2000 MCUs also feature the RISC-based control law accelerator (CLA) real-time co-processor, which is also capable of speeds up to 200 MHz. These two distinct processing resources enable an effective partitioning of the processing load whereby the CLA can take on the control loop processing and other real-time tasks, offloading these tasks from the main core where housekeeping processing, such as communication protocol processing or additional control loop control takes place. The result is far more effective and responsive for overall power system performance.

Drawing on the resources of as many as 12 pairs of high-speed, high-resolution PWMs rated at 150 ps

resolution, C2000 MCUs can drive high switching frequencies and a high number of phases or power rails while reducing the size of the design. Integrated high-speed ADCs are capable of up to 4MSPS and 16-bit resolution. C2000 MCUs also support the most prominent real-time communication protocols, including I2C, SCI, SPI, CAN and PMBus.

By integrating all of the resources needed for sophisticated control architectures into one easily programmable and configurable device, C2000 MCUs reduce the hardware complexity of the rest of the power system while reducing its size and cost. High-resolution ADCs and DACs synchronized to multiple PWM events enable a range of control implementations. On-chip functionality including slope compensation circuits support peak current mode and other sophisticated control mechanisms. Several integrated resources like comparators and trip-zone inputs from multiple sources enable a variety of protection features for the power stage, including overvoltage, undervoltage and overcurrent protection. Multiple on-chip clocks provide redundancy that enhances the reliability of a power system through redundancy of the clock source. In fact, C2000 MCUs feature a triple clock protection scheme with a clock that supports automatic switching to a backup clock when a clock failure is detected.

Development Tools

Developers designing a C2000 MCU into a digital power system can capitalize on the extensive selection of software and hardware tools that streamline the process even for engineers who have limited experience with digital power components. Designers are able to ramp up and complete a development project quickly by taking advantage of TI's powerSUITE graphical software tools, which are a part of the controlSUITE[™] software package. With TI's Digital Power library of fully tested software modules targeting power conversion applications such as PFC, AC/DC rectification, isolated DC/ DC, DC/DC buck converter and DC/AC inverter applications, designers can quickly adapt one of powerSUITE's application-specific software modules to the specific requirements of their system. Coding a new system from scratch is eliminated. The powerSUITE Software Frequency Response Analyzer (SFRA) automates the analysis of the design's frequency response, while the powerSUITE Compensation Designer enables the development of different styles of compensators to optimize closed loop performance. In addition, TI's Code Composer Studio™ integrated development environment (IDE) supports any other software development needed.

A host of application-specific evaluation modules (EVMs) and development boards also accelerate prototyping and experimenting. An interesting example of one of these innovative EVMs is the Digital Power BoosterPack, a plug-in daughtercard for the C2000 Piccolo[™] F28069 LaunchPad development kit. The BoosterPack, shown in **Figure 1**, includes a digital buck converter and tools that introduce the concepts of digital power control and simplify the actual design of digital power control subsystems.

Applications

C2000 MCU-controlled power systems provide the kind of flexibility, processing capabilities and on-chip resources for many of the most complex power applications. These applications include microinverters, string inverters and central inverters for solar applications, power line communication modems for the smart grid, automotive applications for electric and hybrid vehicle charging systems, light-emitting diode (LED) lighting, power conditioners, active power filters, UPS, digital generators and many more.



Figure 1. The Digital Power BoosterPack, a plug-in daughtercard for the C2000 Piccolo F28069 LaunchPad development kit

A Use Case

Server systems offer an apt example of how the vast capabilities of C2000 MCUs can enhance the efficiencies and effectiveness of an application. Integrated into a rack of servers, a C2000 MCU-based power system could control the power distribution to all of the servers in the rack while closely monitoring and reporting on the operations of each server blade in that rack. The overall server supply on-time and efficiency can be improved through the use of C2000 MCUs.

Leadership C2000 Microcontrollers for Power Applications

- C2000 Piccolo TMS320F28035 MCU
- C2000 Delfino[™] TMS320F28335 MCU
- C2000 TMS320F2812 and TMS320F2809 MCUs

UCD3138 Digital Power Controllers

The UCD3138 digital power controller family aims to simplify and enhance power supply design and maximize design flexibility. UCD3138 controllers comprise multiple hardware peripherals that work in unison with an integrated ARM processor. Unlike traditional MCU-based solutions that require fast, complex calculations to stabilize the control loop, the UCD3138 processor is never directly involved in control loop computation. Instead, once configured, multiple hardware peripherals operate autonomously to control the power converter. This methodology allows the UCD3138 processor to focus on other time-critical housekeeping and/or communication tasks. When the need arises, the ARM processor has full ability to interact with the control loop and act accordingly. With UCD3138 controllers, simplicity can be achieved by allowing the hardware peripherals to operate autonomously, but in harmony with the MCU.

At the core of UCD3138 controllers are digital control loop peripherals, also known as digital power peripherals (DPPs). Each DPP implements a highspeed digital control loop consisting of a dedicated high-speed 2-MHz error analog-to-digital converter (EADC), a proportional-integral-derivative (PID)based 2-pole/2-zero digital compensator and digital PWM outputs with 250-ps pulse width resolution. Under this simplified configuration, each loop has a dedicated ADC and configurable digital filter to calculate the control. The control is then translated into a high-resolution digital output to support PWM, pulse frequency modulation (PFM) or phase shift modulation schemes. Three sets of peripherals are available, which operate autonomously once they are configured and simultaneously control three

independent feedback loops. The configurable digital filter has multiple banks of coefficients that can be selected for different power response needs.

Another facet of simplicity delivered by this device family's architecture is in firmware development. Configuration of the DPPs is straightforward and is accomplished by assigning bit values to specific pre-defined registers. UCD3138 controllers do not require complex code development to continuously compute complex mathematical transfer functions. Some digital power designs may require the engineer to deal with the cumbersome exercise of dividing and allocating computation resources across the various tasks to verify that the MCU of choice is sufficiently powerful for the application. The UCD3138 controller family eliminates these concerns with its reduced processor overhead requirement, resulting in a well-optimized device for power supply applications.

UCD3138 devices can be programmed through digital communications interfaces like PMBus or others. These resources have been optimized for high-performance power supply designs, and many of the resources are highly configurable to a range of requirements, making the UCD3138 family ideal for applications across many industries, including network infrastructure, industrial and automotive.

As highly integrated digital power controllers, UCD3138 devices can eliminate discrete chips from power supply designs, reducing the cost and size of the supply. The UCD3138 controller family features integrated power management and power conversion capabilities that support several functions, including sequencing, soft start/stops and other management tasks. All of the commands of the PMBus as well as custom commands are supported for effective power management capabilities. Peak current mode control is accomplished with integrated slope compensation circuits. The UCD3138 controller family integrates several analog functions that provide real-time monitoring and response. This partitioning optimizes the speed and power requirements of the digital control device. These features provide protection functions that include overvoltage, undervoltage and overcurrent protection. An integrated temperature fold-back feature reduces the current instead of turning off the supply completely when the temperature of the power stage exceeds a safe level.

A classic illustration of the increased MCU availability to provide other services is the ability to deliver on-the-fly firmware upgrades. This refers to the ability to keep the power supply running without interruptions while upgrading and commissioning the power supply firmware to a newer version [1]. The UCD3138064 device employs a dual-bank memory architecture, supporting execution from one bank while programming the other. With the critical power supply control and protection functions being managed by dedicated peripherals, the MCU can dedicate its bandwidth toward importing new firmware to the redundant bank, validating that a proper write has occurred and then implementing a well-timed switchover from the older firmware version to the newer one.

Development Tools

TI's Fusion Digital Power Designer provides an efficient development environment with an intuitive graphical user interface (GUI). The Fusion GUI is able to configure the common operating characteristics of a UCD device as well as monitor its performance. It connects to the power controller over the PMBus by way of a universal serial bus (USB) adapter. In addition, the availability of tested and reconfigurable software blocks speed up code development considerably. TI's Code Composer Studio IDE is used for code development with ready-to-use project templates that facilitate quick startup. A wide variety of cost-effective EVM each targeted at a particular type of power supply or function, will accelerate power supply development by facilitating immediate prototyping and experimentation. An example of one of these modules is shown in **Figure 2**.



Figure 2. 1/8 brick isolated DC/DC telecom power module based on the UCD3138 digital controller

Applications

The UCD3138 digital power controller family is a blend of on-chip functionality tailored to power supply designs, but combined with the flexibility of programmable digital processing and configurable analog and digital peripherals. Such a unique blend of power specific and flexible resources allows UCD3138 devices to support a wide variety of applications, including server power supplies, telecom rectifiers, isolated DC/DC power modules, industrial AC/DC converters and automotive power supplies to high-performance PFCs, AC/DC converters, isolated DC/DC supply systems, telecom system supplies, rectifying AC/DC supplies and video communication systems.

Reference solutions for common isolated power topologies such as AC/DC boost PFC, resonant LLC, phase-shifted and hard-switching full-bridge, and active clamp forward are available.

A Use Case

Because of their low pin count, small footprints and cost effectiveness, UCD3138 power controllers have been deployed extensively in power supplies for telecom switching and wireless communications equipment such as wireless base station baseband units, remote radio units and pico basestations. The so-called "brick" power supplies employed in these types of systems place a premium on power density, which is a considerable strength of UCD3138 digital power controllers.

Leadership UCD3138 Digital Power Controllers

- UCD3138 (32 kB)
- UCD3138064 (64 kB)
- UCD3138128 (128 kB)

Digital POL System Controllers

These devices are represented by the UCD92xx family of digital POL controllers. They provide the POL designer with a very high degree of configurability. With this extreme flexibility at their fingertips, system designers can quickly configure the POL's outputs and phases to meet the specific needs of their designs. Advanced POLs are able to control up to four output rails and as many as eight phases. Digital control of the power subsystem's control loops ensures rapid response to variations in input voltages and load current. The UCD92xx family can be configured to provide a nonlinear response when needed. Low latency in the power subsystem can positively impact the overall performance of the system and possibly reduce costs and component count by eliminating the need for additional discrete power components such as certain energy-storing capacitors.

The digital power management capabilities of UCD92xx devices allow for the integration of more sophisticated sequencing processes in complex high-current multiphase applications with many power rails. Designers can carefully prescribe and easily deploy the most effective sequence for powering up and powering down the various rails in the system.

Development Tools

Rapid prototyping and experimentation with TI's POL controllers are delivered through a comprehensive power tool chain featuring the intuitive Fusion Digital Power Designer, the leading user interface and de facto standard for power tools in the industry. With Fusion, designers can monitor power performance and reconfigure parameters on the fly to quickly find the most effective implementation.

Applications

UCD92xx controllers are particularly well suited to systems requiring the regulation of a high number of power rails and multiple phases. In many cases, these types of systems are found in high-speed enterprise networking systems, telecom and wireless basestation switches, and high-throughput test and measurement systems such as automatic test equipment (ATE). Typically, these types of systems feature field programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs) or other sorts of complex logic devices that require a high number of power rails.

A Use Case

Some complex enterprise networking systems and high-throughput telecom switches can support as many as 300 power rails, each requiring tight regulation through nonlinear, low-latency response in the power control loops. UCD92xx controllers monitor power operations and react quickly to anomalies to maintain high system performance.

Leadership Digital POL Controllers

• UCD92xx

Analog Power Regulators with Digital Interfaces

Some power designs do not need a high degree of programmability or configuration, so analog power management devices satisfy the power conversion requirements. However, often there is a need to take advantage of some of the capabilities of digital power like system power management. This can be accomplished through the integration of a PMBus interface. This integration will help reduce component count and BOM costs. For this sort of engineer, analog power regulators with digital interfaces provide a familiar solution and ensure fast design cycles. Analog power regulators with digital interfaces can serve as a first step toward digital power supply design. Designers can retain the analog power architecture they have deployed previously while capitalizing on some of the benefits of digital power management.

TI's SWIFT[™] TPS converters are unique in the industry. Supporting high converter capabilities up to 30 A, they are the only converters with a digital PMBus interface and integrated analog metal-oxide semiconductor field-effect transistors (MOSFETs). By combining both digital and analog circuitry, SWIFT devices are able to offer extensive protection features for the external power stage. The partitioning in these products meets the specific power conversion requirement while providing additional configurable power management functions. For example, such integration enables overvoltage, undervoltage and overcurrent protection. Other power management functions like temperature soft-fail, which scales back the current rather than turning off the power stage completely when the temperature exceeds a certain limit, are also integrated. The on-chip resources let designers fine-tune their topology for noise immunity and transient response.

The inclusion of a PMBus interface on SWIFT converters allows the system to very closely monitor and quickly respond to key output parameters, including voltage and current. In addition, an optional external temperature sensing capability can be linked through the PMBus interface.

Development Tools

TI's Fusion Digital Power Designer tool provides an intuitive programming interface for SWIFT converters, while WEBENCH® tools let developers simulate and modify their designers in one tool. A host of EVMs and development boards work in concert with Fusion and WEBENCH tools to accelerate prototyping and experimentation, reducing the total time of development significantly.

Applications

The high-performance analog power conversion and digital power management capabilities of SWIFT devices are well suited to a range of applications in communications and networking, personal and enterprise computing, industrial automation and process control, as well as solid state storage systems.

Leadership Analog Power Regulators with Digital Interfaces

- TPS53915
- TPS544B20 and TPS544C20
- TPS4042x

A Use Case

Because of their high integration and high performance, low Rds(on), NexFETs technology, PowerStack[™] single-GND pad package, small footprints, high switching frequency, and tight load regulation over an extended temperature range, PMBus SWIFT DC/DC converters have been deployed extensively in wired and wireless communications equipment such as basestation baseband units, remote radio unit pico basestations, 10 Gb/40 Gb Ethernet switches, and enterprise storage systems where power density and thermal performance are key design priorities. New applications include industrial and space/defense such as high-end programmable logic controllers and software-defined radios.

Digital Power Sequencers

The programmability and high integration of digital power sequencers make them an easy and costeffective solution for complex multirail systems where sequencing and monitoring a great number of rails can be a challenge. With an integrated ADC and a digital communications interface for PMBus, I2C or SMBus, digital power sequencers can simplify the hardware architecture, providing an industry standard interface, PMBus, to an optimized power sequencer. As a result, the size of the system is reduced as well as its cost.

UCD9xxx digital sequencers from TI, which can monitor and sequence as many as 24 rails, are among the most capable in the industry. They incorporate a number of power stage protection features, including overvoltage, undervoltage and overcurrent protection. When an excessively high temperature in the power stage is sensed by an



Figure 3. High-performance enterprise switch PMBus power solution

internal temperature sensor, UCD9xxx sequencers are able to scale back the current instead of completely shutting down the converter. Moreover, spare channels can be programmed to control a system peripheral, like a fan through PWM control.

Development Tools

Fusion Digital Power Designer gives developers an intuitive configuration interface through which the many resources of the UCD9xxx devices can be quickly deployed. In addition, EVMs and development boards such as the one shown in **Figure 3** help developers rapidly ramp up prototyping and experimenting during the initial stages of a design project.

Leadership Digital Power Sequencers

- UCD90240 (24 channels)
- UCD901x
- UCD909x

Applications

Digital sequencers find their way into many applications where multiple voltage rails are required. Common applications include telecom and networking equipment, industrial communications and factory automation systems, test and measurement systems such as ATE, servers and other storage systems.

Digital Hot Swap Controllers

Digital resources have brought a much higher level of intelligent power management functionality. An example of this is the role of hot swap controllers in high-performance systems. Hot swap controllers have been primarily analog circuits to manage power during the removal and insertion of circuits into a power source. Similar to the analog POL devices described above, a digital interface has been added to accurately monitor and report, in real time, certain system-level operating conditions such as voltage, current, power, energy and temperature. This allows digital hot swap controllers to play an integral role in protecting the system from hardware faults like shorts or other conditions that might otherwise result in damage to the system. By monitoring and reporting on system power metrics, hot swap controllers support the efficient use of power and intelligent power management schemes.

TI digital hot swap controllers are finely tuned for current measurement, often achieving accuracy ratings better than 2 percent. They include a digital communications interface for supporting PMBus, I2C or another interface. Based on the power monitoring information provided by hot swap controllers, a centralized power management controller in the host system is able to balance power loads, throttle down or up processing elements to conserve power, better manage system efficiency, and predict faults for higher reliability.

Certain TI digital hot swap controllers are compatible with Intel Node Manager, denoted by an "i" suffix in the part number. As a result, these hot swap controllers can provide their energy monitoring information to Intel Node Manager, where it can be used to optimize overall system operations, energy consumption and rack-level performance across multiple server blades.

Development Tools

Balancing the demands of high-power, highperformance systems with high energy efficiency presents a complex set of challenges to developers who are implementing digital hot swap controllers in their designs. Fortunately, TI's tools, such as its Hot Swap Design Calculator, can automatically compute and compare many of the variables that must be considered whether creating a new design, evaluating a current design or troubleshooting a design that is performing poorly.

TI's Power Interface (PI) Commander tool provides an intuitive GUI through which designers can observe the energy monitoring information that is being gathered by TI's digital hot swap controllers. In addition, PI Commander can uncover faults as well as function as a test bed for a hot swap controller's software.

Applications

Prime applications for TI's digital hot swap controllers are typically those where energy efficiency and power consumption are major concerns, as well as those needing hot swap management. Data center and enterprise server systems; video communications systems; and telecom systems, including wireless base stations, baseband units, tower remote radio units and others are areas where digital hot swap controllers are widely deployed.

Leadership Digital Hot Swap Controllers

- LM250xx
- LM506x
- TPS248x

A Use Case

In high-end data centers or enterprise server systems, digital hot swap controllers are a vital link in the energy management and operational control for entire facilities. Power consumption information from each server blade in a massive server farm is imperative if the facility's energy budget is to be maintained. In addition, identifying faults or predicting where potential faults may arise in the future is required to maximize up time. Using this information can mean the difference between shutting down an entire rack of servers because of damage brought about by an unforeseen fault and keeping customers happy.

For more information on these and other TI digital power solutions, see www.ti.com/digitalpower.

References

 Sam Davis, "Power Supply Controller enables 'On The Fly' Firmware Upgrades." Power Electronics magazine, Vol.39, No.5, May 2013.

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