Bodo´s Power Systems®

The ‘Holy Grail’ of Integrated Voltage Regulators (IVRs)

Power management designers have long been the last to complete their power portion of a new system design. At the beginning of the project, they get a very rough view of what the power supply section will need to drive. Often, towards the end of the system design, models or simulations of the system to be powered result in sometimes dramatic changes to the power management requirements (up to 2x).

By Mukund Krishna, Manager of Product Marketing, Empower Semiconductor

With these new requirements and little time, the power designers will typically begin to finalize their circuit design on a ‘postage stamp’-sized area of board real estate. If they are fortunate, a separate power supply board may be allowed, but located ‘who knows where’ in the system, but still on a total area footprint typically too small to handle all the power components along with adequate heatsinking.

Take heart, power designers, enter the Empower Integrated Voltage Regulator (IVR) series EP70xxC with ‘Zero’ external components in a 5mm x 5mm package! A power designer’s dream come true!

Traditional power solutions need many discrete components externally supporting the power IC. This leads to bigger footprint, more complex design, with poor system power efficiency, inadequate response time, and lower accuracy than would be desired. Complexity can be the enemy of reliability and development effort.

The Empower IVR is a patented technology that is able to do what no one has done before---eliminate all external components by integrating them into the integrated circuit (IC). This improves efficiency and provides as much as 10 times reduction in printed circuit board (PCB) footprint. This fully integrated IVR design reduces the power architecture complexity, and that leads towards better reliability of the system as well as a compressed development schedule.

The article will discuss a brief overview of the IVR and its benefits. Then there will be a series of application examples for each application area and how the IVR benefits each application first outside an SoC and later can move onto the SoC.

What is an Empower Integrated Voltage Regulator?

The Empower IVR is a switching voltage regulator, with very high performance, that has all the discrete external components, that other IVRs need externally, integrated within a single package. This makes the power design so much more simplified with the bonus of 50-90% reduction in PCB area footprint.

The Empower IVR uses an advanced CMOS geometry architecture which also enables the IC to be integrated directly onto an SoC package. In some cases, the IVR can be positioned below the SoC either on the PCB itself or the SoC package. Apart from the dramatic reduction in PCB footprint, the Power Delivery Network (PDN) shrinks to levels unachievable through traditional power converters, which waste a lot of power in their PDN.

This IVR exhibits a higher transient accuracy with a 100x faster settling time and nanosecond speed Dynamic Voltage Scaling (DVS), enabling processor power state changes in nanoseconds. Nearly instantaneous voltage delivery will eliminate the excess voltage and wasted power otherwise suffered with traditional power converters. This enables up to 50% savings in energy.

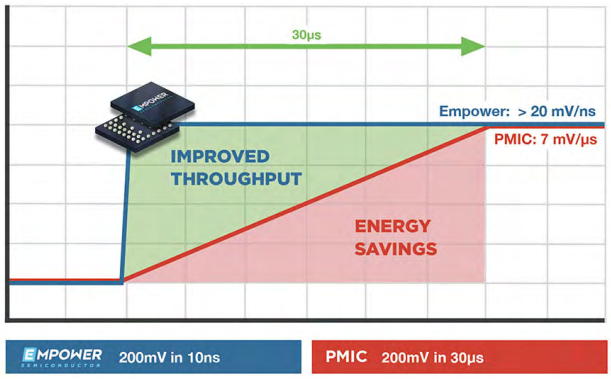

Figure 1: 1,000x Faster DVS Can Lead to 50% Energy Savings

Empower’s development tools make all the difficult decisions that designers traditionally had to worry about. Power designers are able to select their operating preferences with a GUI to configure the IC via a high speed I3C bus.

Improved transient accuracy and faster settling time

Conventional DC/DC converters typically operate at low frequencies, in the region of 0.3 MHz to 3 MHz, in order to have high efficiency in their design. The drawback of a low operating frequency, meaning low bandwidth, is large output and input filtering components to achieve decent transient response. The need for large output capacitors, arranged in parallel, are necessary to get the 100uF or higher capacitance needed for adequate performance. In contrast, the wide bandwidth Empower IVRs lead to high accuracy voltages even during full scale levels with extremely fast transients. Recovery times, with Empower IVRs, are 100x faster with an output voltage drop of 1/3 or less.

Applications

Figure 2 shows some of the main applications for the IVR.
Other applications are Magnetic Resonance Imaging (MRI) and high bandwidth data links such as PCIe

Data Center, AI, and 5G

The rapid growth of Data Center, Artificial Intelligence (AI), and 5G systems are driving the huge bandwidth growth in data centers. There will be 175 zettabytes of information that will need to be managed over the next five years, leading to exponential growth in power/energy consumption with as much as 8,000 TeraWatt-Hour projected over the next ten years.

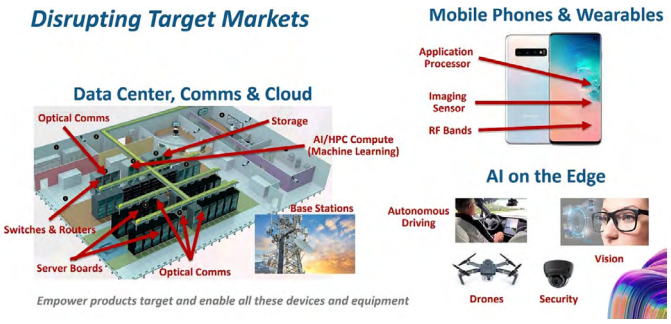

Figure 2: Target markets/Applications

Empower's IVR is perfect for the ever-increasing power density needs in the data center. This IVR series will reduce size and cost, thus improving system efficiencies in network systems, graphics processing units (GPUs), and optical transceivers.

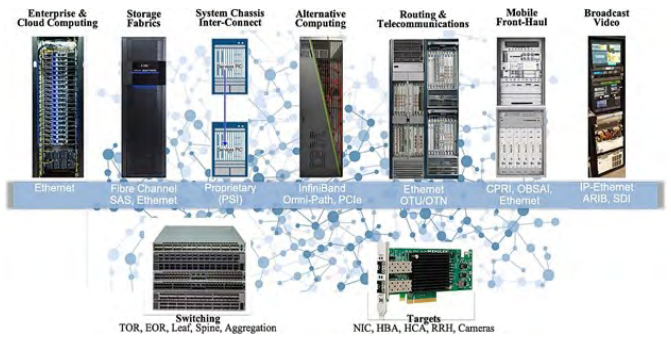

Figure 3: The rapid growth of the Data Center, Artificial Intelligence (AI), and 5G systems has challenging power density needs which will be served by Empower's IVR family

Switches, routers, server, interface cards

In optical network interfaces, communications devices such as switches and routers are usually located a distance away from each other (possibly up to several kilometers), connected with fiber optic cables. The switch or router will process information packets as the transceiver interfaces with the cable and will translate the received optical signal into electrical impulses, and return electrical impulses into optical signals. Empower IVRs are ideally positioned to address the increasing power density requirements driven by the rapid evolution of network data rates. Empower's IVR family has almost ideal transient response, reducing system power management cost, as well as improving system efficiency.

Optical Transceivers

Fiber optic transceivers are the critical components of fiber optic transmission networks. They are designed in a small form factor with integrated optical subassemblies suitable for high-density networks. With the growing increase in speed in optical transceivers, the power consumption of the optical transceiver module inevitably will increase, while the form factor needs to remain the same or even reduce in size and complexity. This will create pressure on the module designer to use highly integrated chips consuming the lowest possible power.

Empower's, no external component, IVR series eliminates external inductors and capacitors, reduces the power management footprint by three to ten times, and improves overall system efficiency. The IVR family's size enables it to be included easily into the transmitter optical sub-assembly (TOSA) as well as in the receiver optical sub-assembly (ROSA).

Processors, AI, GPU

The IVR family will improve transient response, reduce power management footprint as much as three to ten times, and enable vertical power to eliminate distribution power loss.

IVR implementation option

Empower's IVR family enables the power IVR to be very close to the SoC package, either on the top or the bottom of the PC board. The resulting Power Delivery Network (PDN) is much simplified versus a traditional power solution, reducing power loss and thermal stress.

The unique integrated design and performance of the Empower IVR makes it an excellent choice for designers to have the needed flexibility of meeting size, weight, and power (SWaP) in the data center, AI designs, as well as 5G communications architectures.

Figure 4: Implementation option for Empower's IVR

Optical network architectures also greatly benefit from this 'Holy Grail' of IVRs, making these systems more efficient, smaller, and lower cost with less complexity. These all lead to faster time-to-market.

Conclusion

If there were a choice between traditional power converters, and one that offers higher density, requires no external components, provides better performance and enables shorter time to market, the choice is clear.

Power management designers are beginning to discover the 'Holy Grail' of IVR power solutions. Traditional power solutions will no longer suffice, especially when time-to-market is essential, board space is at a premium, and design complexity affects system reliability.

Designers will embrace a single power solution with zero external components. Better transient accuracy with faster settling time and higher transient accuracy are all features that power designers need. Integration into an SoC package or substrate is almost necessary with the current trends.

A GUI that configures the IC through an I3C bus makes a designer's efforts much smoother and faster.

This IVR solution is applicable to a whole range of applications, making it attractive for inventory reasons and making procurement a much happier exercise. Empower is heralding a new era in power design with more of these solutions to come.

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