Power To The People: Power Electronics as a Vertical Market Segment

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 To discuss this subject in broad strokes is no easy task. Power electronics impacts many different areas. My own take on this will be markedly different from the folks that have desk jobs at huge marketing firms that crunch predetermined numbers. I've taken a hands on approach to power from hotsticking and faulting a 13.8KV dead end whipping around my yard with class 2 HV gloves, a welders apron for arc flash protection and a hotstick; to designing and building the actual circuits used in inverters, offline power supplies and point of load conversion. I don't spend much time chasing or purveying buzzwords or marketing fluff. I make stuff work.

To dive right in, there are many places where a semiconductor manufacturer may impact the market. This is by no means a complete list, nor will I delve into subcategories. There simply isn't enough space in this article. This is the market and the directions as I see it.

Communications Equipment
This is pretty low power stuff, but we are building millions of cell phones and handheld wireless gadgets per month. Any reasonable discussion of power electronics needs to consider the PMU's (power management units), Regulators, charge pumps, LED drivers, and ultra low quiescent current DC to DC converters that are in these units. The volumes are absolutely staggering. The future for this segment seems to be leaning toward higher and higher levels of integration. Perhaps the final form will be a PMU that contains ALL power management and an uP/RF chipset that does everything else.

Telecom Power
Telecom power includes all of the stuff that converts the AC power from the utility company to the -48V backbone of most telephony service. It also includes the bricks that take this 48V source and convert it to lower voltages to run processors and FPGAs on massive cards for routing, multiplexing, billing, switching, etc Telecom has clearly had some ups and downs. I remember considering startups that were

burning through VC capital at unheard of rates blazing toward absolutely unimaginable data rates and DWDM densities. Today's telecom is not the Gala OC768 DWDM monsters we dreamed about a decade ago, but a good solid business that consumes High, Medium, and Low voltage switches including MOSFETs, diodes, Schottky diodes and ancillary BJT's; control IC's and digital processing power for advanced control and health monitoring.

Server power and processor power
Size used to be everything--the smaller the better. I've seen 1200W server supplies complete with PFC, EMI filter, inrush limiting, and isolated DC to DC output stages that were smaller than two Hi-C juice boxes stacked on top of each other. Engineers like Bruce Frederick at Emerson have crafted masterful accomplishments in magnetics design, airflow, and power stage architecture. Then there was a turn in the path. Higher and higher switching frequencies meant higher and higher switching losses. There were regulatory programs coming into play that pushed toward higher efficiencies. If they could slow down a little bit and bring the efficiencies up, the industry could offer products that satisfy the new efficiency initiatives in the server space. And that's precisely what they did. A visionary marketer looking for a trend may be thrown off by this, but it's a pretty straightforward response to some added regulatory pressure. The future for server power is bright, but the innovations run DEEP.

The power electronics demand in the server space will shift toward lower loss switches that address the high efficiency regulatory pressures. This will be the forefront of DSP/uP power stage control; however the cost tradeoffs will forever hold a place for the voltage mode/current mode PWM controllers.

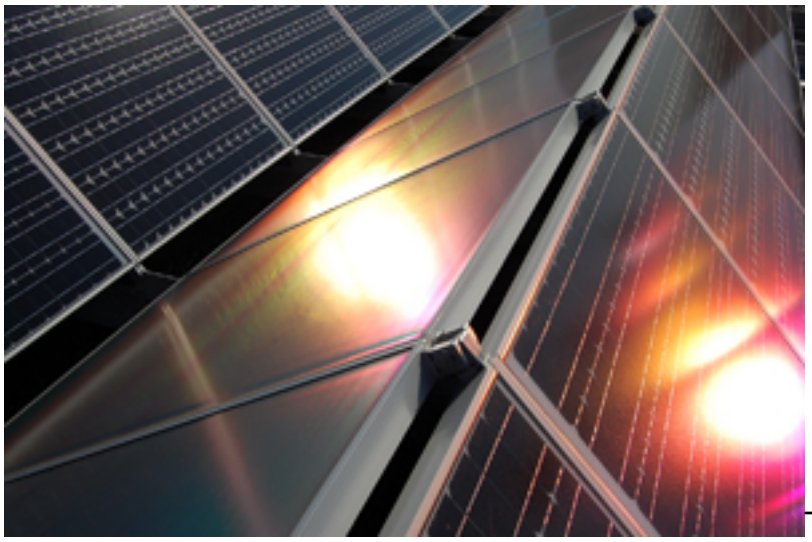
Battery management
This is a BIG up and coming area for power electronics. Most any application that uses multiple lithium-ion cells in series suffers from having the weakest cell dominate the string. The higher the discharge rate, the tougher it is on the weakest link. Processing all of the energy is cost prohibitive. Active cell by cell balancing is absolutely needed. These balancing technologies will extend the life of the pack as well as the capacity. It will also keep the expense of cherry picking 'the right cells' to an absolute minimum. Cordless tools, larger handheld equipment, and hybrid vehicle packs will be the first homes for these technologies. Whether the battery pack manufacturer adds battery management electronics or the OEM adds this technology remains to be seen. This market will expand rapidly as these technologies improve in performance and cost. This will be in the top three opportunities for innovation, growth and prosperity in power electronics.

Merchant Power
This is a large chunk of the power electronics business. Open frame power supplies, bench top power supplies, AC adaptors, and the silver boxes in PC's will always be in demand. This is great industrial business with some admirable innovation toward cost savings. This industry demands a lot of traditional PWM controllers (akin to the UC3842), PFC controllers, power switches, and control circuitry. Most any forward thinker would agree that merchant power will continue to apply price pressures and squeeze more and more efficiency out of a given size power supply with reasonable

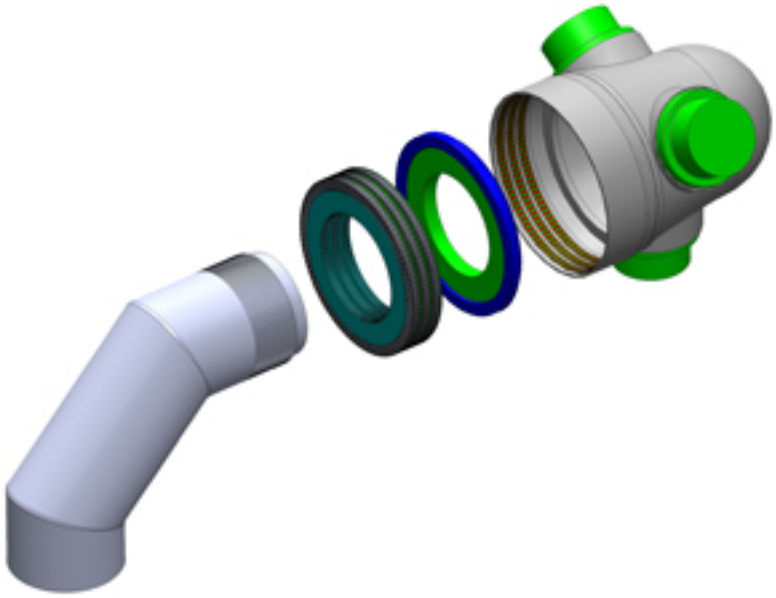
growth.

Utility Power Processing

On the utility side, power electronics is making some new inroads with some old ideas. The grid is overloaded--this is no mystery. Most every semiconductor manufacturer is making a HUGE fuss about the warmed over notion of a Smart Grid from the 1970's. From their end, this is a great way to sell more chips. Frankly, I don't wish the notion well. I really don't want "the man" or "the woman" shutting down my milling machine, my AC, my 'fridge or anything else on my property. That's not smart for me. Regardless, it is clear that we can't afford a new grid (BUT PERHAPS WE SHOULD??!!).

 There are firms like ABB and S and C that are building some great devices to inject harmonic currents out of phase with the currents being consumed by various industrial, commercial and residential loads. This then cancels all of the nasty triplens and odd harmonics allowing far more efficient energy delivery making the load have a displacement power factor of at or near unity as seen by the grid. These devices have power electronics in them and they will proliferate.

The other two arenas in the utility power world are alternative energies like wind turbines and solar arrays. Wind power is subsidized by folks that can just raise the electric bills or the taxes. Those 30,000 LB gear boxes that break every two years on those 3MVA wind turbines require a half million dollar service call. That's expensive. What the heck are we doing putting gears in a high torque low speed environment? The locomotive industry taught us that this was a bad idea a hundred years ago! The good news for the savvy forward thinker is that there is a solution. You might want to check out Norm Rittenhouse's work at EVTglobal.com. His machine IS the solution for high reliability wind turbines moving forward. This will be in the top three opportunities for power electronics to advance the state of the art. Norm and his team are at the forefront with their never ending innovation and emphasis on building the right machine and the right power electronics for the job.



On the solar side, there are some great inverters, solar energy processing techniques, and storage cell/inverter systems or simply grid tied inverters. I've been absolutely impressed at what Dallas Meyer and Joel Cannon are doing at TenK solar. They have not only solved a serious deficiency in solar panels, but in the solution they added the ability to have their panel produce more power per unit area than any other similar panel. This is the third entry in future of power electronics opportunities for innovation, growth and prosperity.

Automotive Power

On the Automotive side, Electric vehicles will also have a significant impact on the power grid. If an electric car can produce 200HP for three hours, it will need slightly more energy to recharge. 200HP is roughly 150KW for three hours that comes out to 1620MJ of energy. If our service panel in our home has a 200A mains breaker, with 240V available, this means that we could recharge the battery in about 9.4 hours if we had NOTHING else running and the conversion efficiencies were ideal. The folks that promote these vehicles as having low carbon footprint fail to realize that those KW*Hours that charge that vehicle don't come from the tooth fairy. They come from the power plant that likely burns coal. From the coal to your home, 50 to 70% of the energy is lost in either Carnot inefficiency or line and conversion loss. The charger and vehicle aren't ideal either. That said, a Dodge 426 Hemi starts to look as green as the Chicago River on St Patricks day.

There is another category in the automotive arena that is getting a lot of engineering support: That of off-road vehicle electrification. This is an up and coming arena for most. This will include stuff like redesigning mining trucks as hybrids, redesigning machinery to eliminate gears, transmissions and hydraulics. This WILL drive significant innovations in energy storage elements, battery chemistry, motor design, and integration.

White Goods/Consumer Electronics
In the white goods industry and the HVAC world, we will see continued push and innovation on more and more efficient machines. This will drive new innovations in motors and related power electronics.

White goods and consumer electronics will see more and more regulatory pressure for PFC, efficiency, low off state power consumption, and price pressure. Class D audio is a shining example of how power electronics can have a positive impact on consumer electronics.

Lighting
The sheer volumes of lighting will likely dwarf my top 3 picks for power electronics innovation. All in all, the power electronics solutions for lighting are fairly simple. LED's require a constant current source with voltage compliance. Some PWM the led's to reduce brightness and retain chromaticity. Dimmable luminaries are all the rage. PFC is mandated for most offline lighting. Price determines most everything.

Where does IR play?
IR actively plays in the Telecom, Server/processor power, Battery management, merchant power, automotive power, white goods/consumer electronics and lighting segments. We align our innovation with the needs of carefully chosen alpha customers through world class FAE, sales and marketing support. Major forward-looking innovations at IR include, but are not limited to GaN devices that will enable much faster switching and much lower losses and Battery management technology.

Conclusion
Power is a lot to talk about. Just like the marketer that asks me to explain all of power electronics, in terms of commutation, control, magnetics design, emi signatures and debug in 30 seconds in an elevator, I am quite certain that I didn't get anywhere near all of the details in this short excerpt. The specific details on the sizes of these markets and the associated dollars and semiconductor spends is best left to the guys that do the accounting, however, most any observer has seen the unending flood of cell phones with more and more functionality, government programs for higher efficiency HVAC equipment, trade in programs for intelligent, more efficient white goods. Programs like this will spur demand. If I can write off 1/3 of a new 3 ton, 15 seer condenser for my hvac system with a scroll pump and a variable frequency drive, that certainly adds appeal.

To discuss Power Electronics as a vertical market requires us to examine how power is delivered to the people, how it is consumed, and how it may be conditioned. A good friend of mine has been a lineman for the last 5 decades. As a youngster, he'd let me climb on his rig and open all the doors and play with all the wonderful tools. When my dad asked me what he did I replied "He gets power to the people". In the power semiconductor industry, we do the very same in principle, only we are once removed--we build the parts that enable power electronics to bring the power to the people.

http://www.ecnmag.com/articles/2010/08/power-people-power-electronics-vertical-market-segment