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Welcome to the ELMG News

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- Embedded systems hardware and software – don't forget the hardware

It seems that the vanilla hardware approach to embedded systems is returning. That is the idea that you have one hardware platform for all your products and change the software to implement various features or parts of your product range. This is a good approach at low volumes but can lead to price point misses at high volumes. Also there are the annoying issues that arise when the hardware reaches up into the software and causes trouble.

A strange version of this occurred when a microprocessor would trigger its own power rail reset generator at seemingly random intervals and at times a code edit would make the problem go away. When we were asked to look at the problem we found that certain sequential bit combinations on the data bus caused the problem. These bit patterns needed to be activated in a certain order. So if the code were recompiled after an edit, it was possible to make the bit combination not occur - although it was hard to tell what a code change would do without looking at the assembler code. So the problem was that certain bit combinations under software control, but not deliberately controlled, caused the unit to reset and these bit combinations were not always made by the compilation and linking of the code. This was effectively an internal EMC problem and was easily fixed by some relatively simple hardware changes. Our client's software team had been looking at it for a couple of months.

So don't forget the hardware and don't forget that the one's and zeros are voltages that change and cause currents in the PCB traces. If you have this type of problem then give us a call.

- Power electronics for power generation.

The grid connection of renewable energy such as tidal energy where the flow rate passing the turbine varies leads to the requirement that the generator operate are variable speed. The AC grid does not operate at variable speeds (hopefully) but at a constant frequency. Interfacing from the variable speed generator to the AC grid involves some sort of frequency changing power converter. Two options present themselves and are used for wind turbines. These are the back to back power converter and the doubly fed induction machine (DFIG). In the back to back converter two three phase converters (generally made with IGBTs as the switching devices) are connected. One converter is connected to the variable speed generator and one to the AC grid. The power flow involves the conversion of the variable frequency turbine connected generator voltage and current to DC and then the conversion of this DC to voltage and current at the grid frequency. Both of these power converters need to be fully rated to the generator power.

An alternative to this back to back connection is the doubly fed induction machine. This involves an induction machine where the rotor winding circuits are available. A three phase power converter supplies current to the rotor circuit and as the frequency of the current in the rotor circuit can be controlled it is possible to generate at the grid frequency while the induction machine operates at variable shaft speed. The rating for the three phase converter can be considerably smaller than the power rating of the induction machine. Having a smaller rating for the rotor power converter limits the speed range over which the generator can operate.

Both types of interconnection methods are commercially available.

It is typical that each generator has its own back to back power converter or DFIG. When the same sort of approach is taken to tidal generation the operation of the turbines underwater puts another constraint on the interconnect as servicing power converters underwater may not be desirable or convenient. (Putting power converters underwater is not impossible and aids in dealing with the heat.) The problem then becomes compounded by the group interconnection of variable speed turbo generators underwater with the minimum of equipment underwater to minimize the forced outage rate from servicing and failures. It would be great to have no controlled converters under water. It would also be great to have no gearbox between the turbine and the generator. How is this achievable? Perhaps a direct connected permanent magnet AC generator unit connected to a diode rectifier would be appropriate. The machines can then be group connected at their DC terminals minimizing the cabling underwater. There are issues around the interaction of unit connected permanent magnet DC generators with each other that suggest that constant current type techniques would be suitable control approach to this interconnection.

- Can power electronic power density increase indefinitely?

I recently had a conversation where I was told that eventually a 2kW telecoms type 48Vdc power supply would be smaller than a cell phone. I was thinking about this and decided to have a look at the key drivers and road blocks in power converter density. Switching device speeds are getting faster and the on resistances or voltages are falling, leading to faster switching speeds and smaller magnetic and capacitive components. However if the 2kW power supply is an AC single phase unit and the input current is a sinewave then it is necessary that a 100Hz (in the 50Hz world) or 120Hz (in the 60Hz world) current flows on the DC side of the rectifier. This second harmonic component needs to be filtered with a capacitor and as such the limiting factor in the density of a single phase power supply is the rate at which the energy density of power capacitors is increasing. It is interesting to look at the power density log v log graphs that we all show our customers and draw the rate at which capacitor power density is increasing. A good introduction to this is the paper PWM Converter Power Density Barriers. By Kolar, J. W. et al. This paper is available at http://www.pes.ee.ethz.ch/research/staff.php?lang=en&showCV=42

Other areas that will possibly pose problems are the connection terminals and third party certifications for the PSU.

- EMC – watch out for the common mode

More often than not when we are asked to look at an EMC problem it is a radiated emissions problem where the emission have been reduced to nearly below the line but no further circuit improvement, be it optimized impedance control drivers or bandwidth limiting filters makes any difference. However the addition of a common mode choke gets the emissions under the line – usually only just.

It is always better to design in your common mode solution at the very beginning of the development but this does not always happen. Retrofitting a common mode solution is often useful.

As a final point if you have an off board interfacing problem and are tempted to use a parallel bus, think instead about a suitable serial bus as the control of common mode currents is typically simpler for a serial bus.

From the FAQ page

I plan to design a product, get UL to test it and then change it a bit where it fails and get UL to test it again. Is this a good plan?

In short, no. It is unlikely that this approach will lead to successful product with a reasonable development cost or in a reasonable time. The time to market will be long and the cost of UL personnel time and lab testing time will be expensive. The approach may also annoy your UL test engineer. Better to design it correctly (ask ELMG how now at enquires@elmgnz.com), involve UL early, test it once, then put it on the market and make lots of money