Cloud data center server power and optical transceivers: a dynamic duo

Steve Taranovich - March 09, 2017

In my recent visit to Silicon Valley, I met with Maxim Integrated’s Vice President Dr. Craig Teuscher, and Bill Numann, Executive Director of the Cloud & Data Center solutions. Dr. Teuscher was a co-founder of Volterra, which Maxim Integrated purchased in 2013. Numann joined Volterra in 2000 and was a senior VP there. He ran the server, storage, and communications in 2012.

I was impressed with their strategy to provide two very key solutions for the power and communications technology used in data servers. Cloud server growth is on a steady rise and grabbing market share from enterprise servers, which are on the decline.
Cloud servers are overtaking enterprise servers in market share
(Image courtesy of Maxim Integrated)

Optical solutions for the data center for 25, 40 and 100G

Data centers store and process data for users to access in real time; having high speed optical transceivers improves data center density.
Next-generation optical interconnects are driven by rapidly increasing data traffic in the cloud, for data center speeds 400 Gb/s and beyond. Transmission capacity will be achieved by combining higher channel rates and wavelength-division multiplexing (WDM) technology. Although there is an urgent demand for higher transmission capacity, cost and power consumption of optical links need to be reduced.

Maxim designers have chosen to design their optical solution with the laser drivers external to the transmitter optical sub-assembly (TOSA). This keeps the heat of those drivers away from the TOSA. Temperature variations will cause wavelength changes to the laser in a linear fashion, especially in 25G speeds and up. In addition, an increase in temperature causes a decrease in the optical power at the laser output. Finally, laser power sensors can also be adversely affected by temperature which degrades their accuracy in a feedback circuit controlling power levels.

External laser drivers are in the transceiver. The receiver optical sub-assembly (ROSA) is shown here as well.

The TOSA converts an electrical signal to optical and then couples it onto an optical fiber. The TOSA is made up of a laser diode, optical interface, monitor photodiode, metal and/or plastic housing, and electrical interface. Sometimes filter elements and isolators are included in the assembly.
Data center-oriented power management solutions

The Volterra acquisition brought with it an advanced packaging technology for improved heat removal in their power solutions as well as a small-form magnetics design IP. The company was well-known for their high speed/high efficiency designs coupled with small form-factor design architectures. This enables the power element to be moved closer to the high speed, power hungry processors (GPUs can require as much as 300 W), saving power and lowering parasitic effects due to the shorter line length of PC board connections.

The key part of the power technology that Volterra developed for their designs is a “Coupled L” architecture which many times have been used in multiphase topologies with the advantage of current-ripple being cancelled out from magnetic coupling between the phases. Current-ripple cancellation usually only happens at the output of a multiphase buck converter when discrete inductors are used. When the inductors are magnetically coupled, the current-ripple cancellation is applied to all elements of the circuit: MOSFETs, inductor windings, as well as PCB traces.

With this method, the switching from all the phases affects each single phase, so the current ripple is reduced in amplitude and multiplied in frequency. Reduction in the RMS of the waveforms can improve the efficiency of the power converter or be traded for smaller magnetics, faster transient and leads to smaller output capacitance and the ability to get rid of large bulk capacitors.

The 12V solution

Maxim Integrated’s 12V power solution can lead to a 33% reduction in board footprint; this can save over 1W per CPU.

Server owners need to consider increasing electric bill costs as processor speeds and DRAM Memory demand more and more power and contribute to 80% of the power in servers. The total cost of ownership (TCO) is a prime factor that owners must consider and this drives the need for lower power architectures.

Enter the new rack architecture

With servers now consuming 2% of the world’s power (The equivalent of powering all of Italy). Data servers just in the US are forecasted to 140B kWhrs by the year 2020 when 5G should be in effect.
Google threw down the gauntlet with their announcement at the 2016 OCP Summit for a 48V rack power architecture. Now the power challenge was to provide an efficient 48V to sub-1V level Point-of-load (POL) regulator design for the CPU and the memory.

Google’s new 48V to POL power design will lower power conversion losses by as much as 30%, lower power distribution losses by as much as 16 times, and power losses based upon the PUE rating.

**Maxim Integrated 48V to core solution**

Maxim designers used the same core technology in which they were successful in 12V rack power systems and used that concept in implementing their 48V architecture.
Maxim’s 48V to Vcore solution uses two phases per IC, has integrated loss-less current sensing, as well as energy recovery. This design has excellent transient response, which Maxim claims is best-in-class (processors demand high currents very quickly).

**Scalability**

- Their Primary side Vin can span from 40V to 60V
- The transformer ratio is 6:1 with a 10V secondary; it uses a multiphase architecture with up to eight phases with high load current at each scalable transformer stage
- The secondary side controller can drive up to four scalable transformer stages
- The secondary power stage architecture is comprised of a Synchronous rectifier scheme
- The design architecture can accept an optional isolator with primary to secondary isolation of 600V providing noise relief; the architecture allows for a quick response with just a 15ns transit delay

**Editor’s note:** Since each customer’s design needs for power are unique, Maxim Integrated has chosen to address each one individually for this market. I know, from first-hand experience, how good the Volterra architecture is. Their buck converter architecture has the driver tightly coupled to the power FET. The inherent small size and high level of integration of this design allows for the obvious small board footprint, but more than that, allow the FETs to exchange current more quickly—parasitics are kept extremely low in this neatly compacted architecture and this means greater efficiency as well. Finally, no external bulk caps are needed to compensate for large switching losses due to their flip-chip which also enables the shortest distance to capacitors, thus lowering switching losses as well.
Here is the Maxim Integrated strategy:

Maxim builds integrated power and optical solutions in cloud data center and network infrastructure. These products aren’t necessarily sold as standalone parts—they are specific to the customer’s architecture. For more information and to sign up for product notifications, go here to Maxim Integrated’s 48V Rack Power Distribution site.

Also see:

- Data center next generation power supply solutions for improved efficiency
- 48V direct-conversion dramatically improves data-center energy efficiency
- Silicon Labs timing technology for coherent optical market