APEC Rap Session Ponders Progress, Prospects And Pitfalls For GaN Devices

by Kevin Parmenter, Contributor, Phoenix, Ariz.

At this year's Applied Power Electronics Conference (APEC 2015) in Charlotte, N.C., I was once again honored and privileged to moderate the rap session on wide bandgap semiconductors. This is the third year in a row this topic has been included among the three Tuesday night rap sessions and this was possibly the most popular of the three sessions as the room was filled to capacity with approximately 450 individuals. Free unlimited beer helped fuel the session and keep things lively.

Although the wide-bandgap topic was being revisited, the treatment of the subject has been evolving. The theme this year was "Wide Bandgap Semiconductor Devices in Power Electronics —Who, What, Where, When and Why?" Moreover, the focus narrowed to address just gallium nitride (GaN) because there is a widely held belief that silicon carbide (SiC) is further along in finding its way and entering mainstream applications, especially in the higher voltage areas.

The distinguished panelists this year included the usual representatives of semiconductor device manufacturers but also some representation from the power supply field with practicing design engineers in the group:

- Ionel Dan Jitaru, owner and founder of Rompower, an internationally recognized engineering firm in the field of power conversion;
- Alex Lidow, Ph.D., CEO and co-founder of Efficient Power Conversion, a manufacturer of enhancement-mode GaN power devices;
- JJ Wilkerson, senior engineer at Excelsys Technologies, a manufacturer of high efficiency, low profile power supplies for a variety of specialist markets;
- Eric Persson, executive director, applications and marketing at International Rectifier/Infineon, a power semiconductor manufacturer whose broad portfolio includes GaN power devices, both cascade and enhancement mode;
- Larry Spaziani, VP of GaN Systems, a manufacturer of enhancement-mode GaN power devices;
- Robert White, president of Embedded Power Labs, a power supply design consulting firm;
- Ron Vinsant, member of technical staff, Vishay, a power semiconductor (and other components) manufacturer. Vishay does not currently offer GaN.

Naturally, the audience also included many practicing design engineers who could directly participate in the discussion by addressing their comments and questions to the panel via the traditional open microphone approach. We also used an audience response tool called Poll Everywhere to solicit questions from the audience, which could submit them via text messaging.

Alix Avron from Point the Gap, a marketing research and consulting firm, kicked off the discussion with a brief presentation on where GaN power semiconductors are from a business perspective. Avron gave a great overview of the business volumes and participants involved in providing devices to the market.

This overview was not only where we are today in terms of who the players are and how much they are selling, but also where things are going. GaN sales are projected to be 1.5 billion or so by 2024. Having said that, we must note that humans are historically very bad at predicting the future especially when it comes to the dynamic, competitive, merger-and-acquisition rich environment, which is the semiconductor industry.

After the presentation on the business landscape, Dan Jitaro of Rompower presented exceptional work on substituting GaN devices in place of silicon devices and the resulting improvements and performance gains in several applications.

Meanwhile in his comments, Alex Lidow noted some of the constraints, impediments and challenges that are still to be solved. Among them are packaging, (Lidow says get rid of the packaging—perhaps creating system level functional modules), improving the test equipment available to test GaN devices, making the devices even

better at lower costs, reducing risks further to the designer; increasing operating voltages to give more margin in the designs and likely other things we have not yet considered.

The panel and members of the audience expressed many other opinions. For example, it was also noted that for GaN to experience wide adoption, strides need to be made in the ecology—drivers, controllers, magnetics, packaging, and hybrid function modules containing GaN all need to be employed to take the risk out of applying GaN power technology. Another was that the semiconductor industry will need to provide compelling data of performance and reference designs that can demonstrate real tangible benefits—smaller size, lower BOM cost, and higher efficiency at a low risk to spur adoption of the new technology.

What else needs to be done? Ease of trial needs to go up and innovative packaging and complete system solutions must be offered. Designers also must have the ability to obtain appropriate test equipment, specifically oscilloscope probes that can measure such high slew rates. All these challenges have to be overcome and who is going to pay for it? Finance guys are famous for "show me a business case and I will make a product" while engineers are famous for "show me a product that solves my problem and I will give you a business case." So, who will move first?

The audience submitted many questions for the panel and even asked some questions which the audience self answered such as "are GaN devices available in die form," which of course they are.

Several people asked a question to the effect, that if the market is only going to be 1.5 billion in 2024, then won't the market actually be smaller than the investment in the technology? One response was simply the comment noted above, that humans are historically poor at predicting the future. But that aside, this is a good question and I'm not sure I have an answer other than what I said at the rap session--do you want to live in a world where all you have to design with are old parts? You want to have the latest innovative components, right? But the question about the market size remains and there may not be a right answer at this time.

But going back to the point about our inability to forecast, just recall the early expectations of the first silicon transistors. At one time transistors were only projected to have applicability in car radios and no other uses were anticipated or considered. It's also interesting to consider that silicon has had 60 plus years of having the best minds on earth beat the cost out, increase performance and innovate in packaging. Meanwhile, GaN is just getting started as a material useful in power electronics, but also benefits from having a track record in other areas of electronics. GaN is widely adopted and mainstream for LED lighting and it's getting mainstreamed in RF power amplification applications.

Overall, the comments from the audience suggested that the adoption of GaN devices will depend on the demonstrated performance improvement being greater than the risks of adopting something new in a design. Power electronics design engineers are inherently risk adverse and at a certain level of performance, the benefits will overcome any perceived risks.

Time will tell if we will be having this same rap discussion next year or at what point in time GaN power technology will simply be part of our standard toolbox, i.e. what we use on a daily basis to solve complex power design problems and decrease size and weight, increase efficiency, lower total system cost and decrease cost of ownership for the end product application.

If you would like to review the rap session presentation it is available here. And if you have any questions you can contact me or any of the rap session panelists via the websites listed below.

- Rompower
- Efficient Power Conversion
- Excelsys Technologies
- International Rectifier
- GaN Systems
- Embedded Power Labs
- Vishay
- Point the Gap

About The Author

Kevin Parmenter has over 20 years of experience in the electronics and semiconductor industry. Kevin is currently vice president of applications engineering in the USA for Excelsys Technologies. Previously, Kevin has served as director of Advanced Technical Marketing for Digital Power Products at Exar, and led global product applications engineering and new product definition for Freescale Semiconductors AMPD - Analog, Mixed Signal and Power Division based in Tempe, Arizona.

Prior to that, he worked for Fairchild Semiconductor in the Americas as senior director of field applications engineering and held various technical and management positions with increasing responsibility at ON Semiconductor and in the Motorola Semiconductor Products Sector. Kevin also led an applications engineering team for the start-up Primarion where he worked on high-speed electro-optical communications and digital power supply semiconductors.

Kevin serves on the board of directors of the PSMA (Power Sources Manufacturers Association) and was the general chair of APEC 2009 (the IEEE Applied Power Electronics Conference.) Kevin has also had design engineering experience in the medical electronics and military electronics fields. He holds a BSEE and BS in Business Administration, is a member of the IEEE, and holds an Amateur Extra class FCC license (call sign KG5Q) as well as an FCC Commercial Radiotelephone License.