Empowering the Electronics Industry

2017 PSMA POWER TECHNOLOGY ROADMAP

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Purpose of the PSMA

The Power Sources Manufacturers Association (PSMA) is a not-for-profit organization incorporated in the state of California. As stated in the papers of incorporation, the purpose of the Association shall be to enhance the stature and reputation of its members and their products; improve their knowledge of technological and other developments related to power sources; and educate the electronics industry, academia, and government and industry agencies as to the importance of, and relevant applications for, all types of power sources and conversion devices.

PSMA Mission

The PSMA mission is to integrate the resources of the power sources industry to more effectively and profitably serve the needs of the power sources users, providers, and PSMA members.

The PSMA Power Technology Roadmap Report is devised and intended for technology assessment only and is without regard to any commercial considerations pertaining to individual products or equipment.

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Foreword

When an industry roadmap document is titled "Empowering the Electronics Industry: A Power Technology Roadmap (PTR)", it signals either excessive hyperbole or an industry confidently emerging from the shadows to play a leading role in the next phase of electronics industry evolution. We hope that as you are perusing this tenth edition of the PSMA PTR report, you will find more evidence to support the second interpretation.

This report, like the previous PSMA PTR reports, is a result of the collaborative work by all volunteer participants, who happen to be leading experts in their respective fields. As a result, it pulls together a spectrum of valuable information that brings different perspectives tied together by common format and template that have been crystallized over time. This report is unlike any other in the power technology industry and we hope the readers benefit from its many insights.

This report is the tenth Power Technology Roadmap. The first report was in 1994. The next report came out in 1997 and the cycle was repeated every three years until the 2009 report. In 2009, the PSMA membership requested an increase in the frequency of the report to provide more timely updates to the power sources industry. As a result, this roadmap report is now published every two years; in 2011, 2013, 2015, and now 2017.

The Power Technology Roadmap is one of the benefits of membership in PSMA. Please share this copy with others within your member organization. Additional copies of this report, or any other PSMA publications, can be purchased at psma.com or by calling the PSMA office. Non-members of PSMA may also purchase copies of the report at psma.com or by calling the PSMA office.

Philosophy

The goal since the inception of the report is to review, comment, and capture power conversion technology and trends for the next two to five years. As the industry evolves, the content of the report changes, while many of the tracked quantitative metrics are retained for the sake of consistency.

This edition of the report reflects some significant changes in the profile of the power conversion community. In the last roadmap edition, the power conversion markets were described as technology responsive, rather than technology driven. This statement largely remains true for traditional applications in computing, consumer, and telecommunications segments. In these applications, the end user is indifferent to the inherent features or other details of the power conversion technology embedded within the product or equipment. In this 2017 report, it is obvious that many emerging applications have power conversion technologies at their core and the industry has, in many areas, become technology driven rather than technology responsive. These technology-driven areas include solar inverters, variable frequency drives, electric vehicles, and LED lighting systems.

The technology pull from the power technology customers and original equipment manufacturers (OEMs) comes in many forms. Sometimes requirements are for differentiation by the manufacturer or end-customer demands. At other times, requirements are driven by regulatory environments. Industry competitiveness also drives smaller size, higher efficiency, better electrical performance, and lower cost.

These requirements result in severe technical challenges in the design, manufacture, and even the selling process. These challenges push all of us to strive for new levels of excellence in our respective businesses. We need better materials, better components, better solutions, and more effective ways to manufacture and deliver them. Our interests are best served by taking a proactive stance – by anticipating these challenges and developing the technology required to meet them on time or ahead of time.

It is in this spirit that the PSMA has been conducting these Power Technology Roadmap activities since 1994. Leaders from the key groups – supply manufacturers, component suppliers, end users, and power industry experts – contribute their views through a year-long series of public webinar presentations to facilitate convenient attendance and data gathering. The webinars cover a wide range of power conversion topics loosely grouped into Application Trends, Component Technologies, Emerging Technologies, and Power Supply & Converter Trends. This is combined with the work of volunteer working groups that analyze industry trends and ultimately produces the output that is this report.

What's New This Year

The PTR report has always tried to provide multi-dimensional perspectives on power technology growth and evolution. After starting with predictions for four major product segments, Applications Trends and Emerging Technologies commentaries were added in 2011 and 2013, respectively. In this edition, a new section on Component Technologies has been added. It is widely recognized that the power technology growth is strongly impacted by the growth (or lack thereof) of underlying component technologies. In prior roadmaps, the component angle was covered through the webinar presentations, but we hope that the addition of this new section will provide further insights and value to the readers.

Other than the addition of Component Technologies, this year's roadmap report largely follows the format of and keeps the improvements made during the 2015 report.

Since the webinars have been opened to the public from the 2013 roadmap report, the attendance and interest level continues to grow. This also leads to interesting discussions at the end of the webinars between attendees of diverse backgrounds. We welcome these discussions and they contribute to how we understand our industry and the underlying power technologies. Sharing information and improving knowledge is, after all, the goal of PSMA. During this roadmap cycle, an effort was made to start the webinar presentations early (from January 2016, instead of April as in previous years) to accommodate more diverse set of presentations.

We continue to include the recorded webinars on the USB drives. The webinars add much to the presentation materials because the listener can hear and understand the context and the subtext of the original presentation in the speaker's voice.

The 2017 roadmap report keeps the two sections of written trend forecasts – Application Trends and Emerging Technologies. The reason to keep them separate remains: emerging technologies may not be application specific, though the boundaries can blur. Some, but not all, of the Application Trends or Emerging Technology commentaries could fit into the introduced Component Technologies section.

We continue to use an online survey to gather trends data for four power supply and converter product segments. The increased participation has helped provide a more accurate picture of where we are today and forecast changes to expect for the next five years. However, the editors of each segment exercise judgment to validate and/or filter the survey data to present a coherent picture.

While the roadmap report looks to the future for power technology trends, we should also be cognizant of history. It is not possible to include the content of all the previous roadmap reports, but recognizing the previous work and topics discussed shows the evolution of topics and trends. We have provided a listing of the previous years' presentations and their authors in Appendix III for that background.

The end result of all the webinars, surveys, and discussions is this report. It offers a consolidated view of the latest trends in the power management, power control, and power delivery technologies. We hope you find it useful, thought provoking, and valuable.

Conor Quinn and Dhaval Dalal
Roadmap Chairs

Acknowledgements

The PSMA Power Technology Roadmap is a result of the collaborative work by all volunteer participants.

We would first like to thank the presenters, each of whom put many hours into the webinars. A large portion of the success of the PTR is due to their efforts in preparing their materials and their skills in delivering their information clearly and concisely.

Likewise, we thank the authors for the Applications Trends, Components Technologies, and Emerging Technologies articles and the Power Supply and Converter Trends summaries. They are industry experts who have taken time to articulate what they see as major trends and challenges in each vertical application segment and overarching technologies applicable to power electronics.

Special thanks are warranted for the segment leaders, whose efforts were essential to completing this report. Thank you to Alain Chapuis and Brian Zahnstecher (Ac-Dc Front-end Power Supply Segment); John Wiggenhorn and Stephen Oliver (External Ac-Dc Power Supply Segment); Ian Mazsa (Isolated Dc-Dc Converter Segment); Arnold Alderman, Cahit Gezgin, and Jeff Nilles (Non-Isolated Dc-Dc Converter Segment); Ajay Hari and Chris Jones (Application Trends section); Brian Narveson (Emerging Technologies section); and Vittorio Crisafulli and Tim McDonald (Component Technologies section).

The report was further enriched by a crew of contributors — a mix of leading power technologists and component experts. Their efforts became power supply design trend tables, which provide the very important quantitative element of this report. These contributors also supplied summary excerpts that provide insights to complement the tabulated survey results. A complete list of all presenters, authors, and contributors is included in the appendix.

Laurie House helped edit the full report and kept things together during a chaotic race to the finish line. Aung Tu provided many valuable tips based on his many years' experience with the report and also stepped in to edit the video files.

Finally, the PTR webinars and this report cannot succeed without the help of Joe, Judy, and Lisa Horzepa of PSMA. Joe, Judy, and Lisa did a great job arranging the meeting facilities, providing great feedback through the process, and managing the book printing and USB drive duplication process. We also thank the PSMA board of directors for their steadfast support.

The PSMA Power Technology Roadmap remains a two-year effort. We hope that the many of the current volunteers will continue to support and that new volunteers will join this extremely rewarding effort.

Conor Quinn and Dhaval Dalal
Roadmap Chairs

