Resistors Are Getting Smaller and Less Expensive

In the March 2018 issue of *IEEE Power Electronics Magazine*, this “Happenings” column presented some interesting developments in electrolytics and film capacitors. This issue of the magazine turns its focus to the resistor industry. At first glance, the prospects for finding research and development activities in the resistor supply chain seemed less promising than for inductors or, for that matter, capacitors.

A walk through the exhibition hall at the Applied Power Electronics Conference and Exposition (APEC) 2018 offered mixed hope. There were a substantial number of exhibitors advertising resistors. But a quick scan of the wares on display was not encouraging. Many of the products looked like they were the same as when this writer, now in the later stages of a long engineering career, was new to the craft. Some of the more interesting offerings were water cooled. While intriguing, they were essentially identical to a product that could have been designed for the same duty 40 years ago, hardly likely to change the industry and not a great prospect for a “Happenings” column.

In the following weeks, however, things started to look up. Not all of the offered contacts were willing to complete the connection. But there are people who are known for their knowledge of what is going on at the cutting edge of resistor technology. They are hard to identify in a world that, for the most part, wants to know how many of which part numbers you wish to order. It is even harder to identify one who has an interest, or even an apparent willingness, in sharing their knowledge with the readers of this magazine.

Enter Tom Morris, a senior applications engineer at the IRC division of TT Electronics in Corpus Christi, Texas. A telephone conversation with him reveals that he does indeed know a lot about resistors. He knows how they are made and how they are used. A Google search reveals that his name is associated with a number of relevant current links about the construction and application of resistors and other power electronics products. He knew that the telephone call was to be about resistors, and he began with great enthusiasm. When asked to limit himself to what is new in the resistor industry and where trends are leading, he hardly slowed down. First, he said that the resistor industry is not the most revolutionary, but he then set out to describe a process of relatively rapid evolution.

He told a story of progress toward smaller, lower-cost, higher-efficiency resistors. When questioned, Morris agreed that the sense in which resistors are growing smaller is that they are able to dissipate an increasing amount of power for a given size. The emphasis on lower cost was surprising. It is probably uncommon for resistors to be an important cost contributor to the overall materials cost of an electronic product, so one might think that this might be one item that does not compete that intensively on cost. But the subject came up repeatedly over the course of the conversation, so the issue is evidently quite important to him.

His emphasis on efficiency was initially confusing. It would seem that all resistors are either 100% efficient, if their mission is to convert electric power into heat, or 0% efficient, if their job is to convert electrical power into any other sort of energy flow. But listening to Morris, it became evident that efficiency for
him did not mean power efficiency but rather some measure of process efficiency, the ease with which the factory produces a useful product. In this sense, it is perfectly logical that efficiency would be important if a low-cost product is a goal. A related trend, which was noted by one of the parties at a booth in the APEC exposition hall, is to offer even physically large resistors (a centimeter or more in all dimensions) in surface-mounted packages.

According to Morris, one of the bright spots in the resistor industry is current sense resistors. These commonly are built to tight resistance specifications. In recent times, these have moved down a lot in the range of available resistances, to as low as 100 \(\mu\Omega\). As switched-mode power supplies are increasingly produced at higher output power and at lower output voltage, the current that needs to be sensed is rising. Also, as the output current increases, the loss in the sense resistor becomes an increasingly important source of inefficiency. There is a strong incentive to make the sense resistor have enough resistance to get the sensed voltage above the noise floor but no higher—thus the need for lower resistance components, which are difficult to make in a cost-effective manner. When asked about details of the production process, Morris answered very politely, but in a way indicating that follow-up questions were unlikely to provide further enlightenment.

Another growth industry within the resistor marketplace is resistors with improved pulse or surge ratings. These are used even in systems far enough removed from central station power that lightning surges are not a concern. This is because there are other sources of radiated energy within an interconnected system of power electronics components that can place a large temporary load on a resistor under some infrequent conditions. The ability to survive these occasional events and remain fully serviceable is a highly desirable attribute. Morris also remarked that the industry does not appear to be making significant advances in stability. This is apparently due to a lack of market demand for such resistors rather than any inherent inability to produce them. Additionally, precision resistor functions are increasingly being integrated onto silicon rather than being performed with discrete resistors.

In summary, it seems that resistors are an evolving technology. They are getting smaller and less expensive. They are produced to specifications not formerly available. These trends are being supported by manufacturing knowhow that is not widely publicized and is certainly protected as trade secret practices at some level. Do not anticipate a change in this marketplace comparable to the wide-bandgap semiconductor revolution, but do expect the resistor industry to continue to evolve to support the changing needs of power electronics systems built with the new technology.

**About the Author**

Tom Keim (tkeim@alum.mit.edu) is a late-career engineer and a longtime Member of the IEEE. His specialty is high-performance electromechanical systems and the power systems that drive and control them. He has worked for a worldwide conglomerate, for a small (50 employees) innovative research and development company, for a major research university, and for an engineering consulting company. He has 50 publications and 11 patents and is currently active as an author, inventor, and consultant.