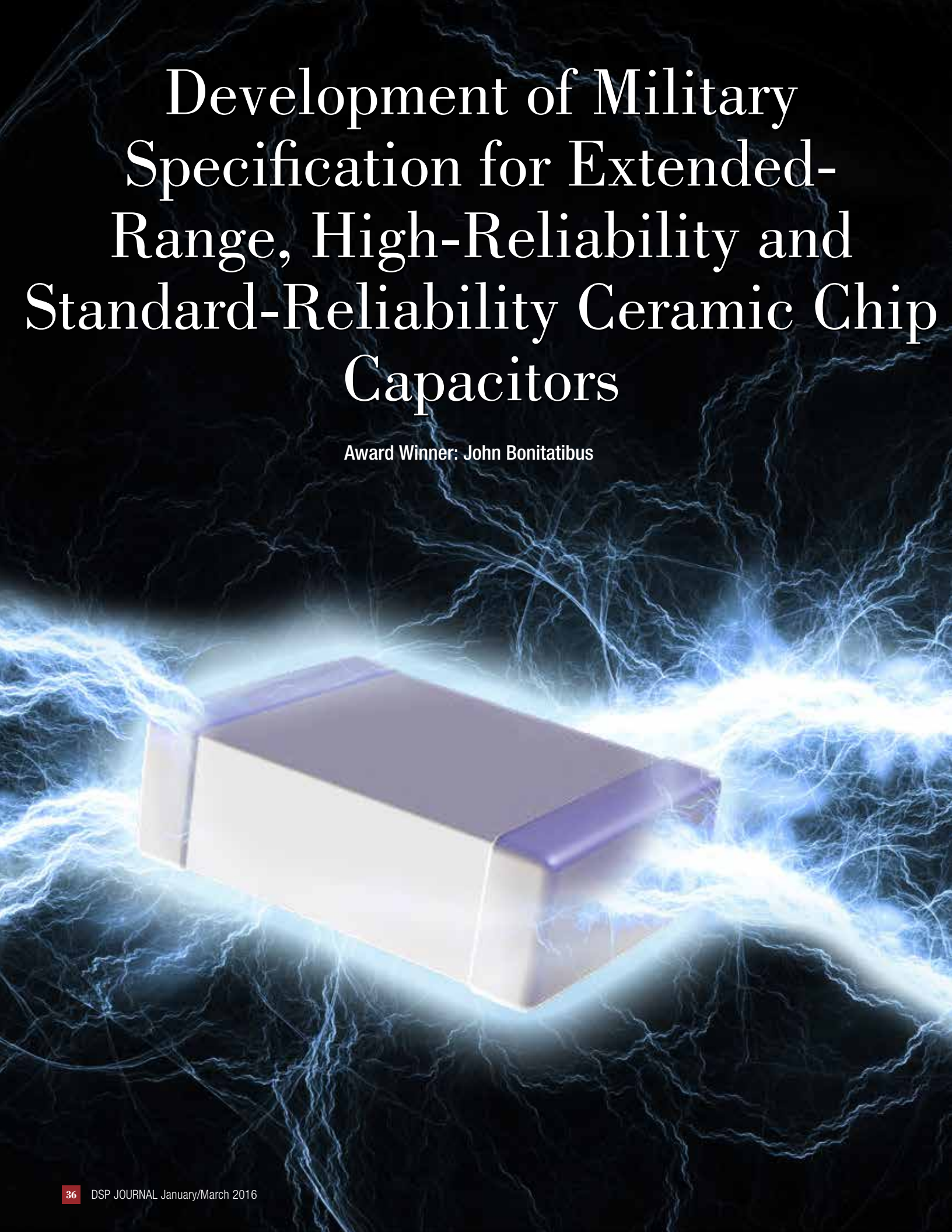
Development of Military Specification for Extended-Range, High-Reliability and Standard-Reliability Ceramic Chip Capacitors

Award Winner: John Bonitatibus



John Bonitatibus of the Defense Logistics Agency (DLA) demonstrated outstanding leadership and accomplishments in the significant engineering standardization effort with the development of a new specification (MIL-PRF-32535) and 10 specification sheets covering extended-range surface mount ceramic chip capacitors for high-reliability and standard-reliability applications. Mr. Bonitatibus completed the multi-year effort with the dating of the specification and 10 associated specification sheets on September 28, 2015. He is continuing work on three additional specification sheets.

Background

Mr. Bonitatibus is the lead engineer for capacitors at DLA Land and Maritime. He knew that the use of smaller capacitors with higher-capacitance values was rapidly increasing in new programs. The desire for lighter, smaller, and faster systems is driving the need for ever smaller and faster electronics to meet mission needs. Mr. Bonitatibus knew that the needed capacitors were not available as a military product.

Problem/Opportunity

Mr. Bonitatibus knew that a standardization document covering higher-capacity surface mount capacitors in sizes smaller than those in current military specifications was desperately needed. Designers have been using commercial capacitors with unproven reliability in their systems, and Mr. Bonitatibus had been receiving requests to approve nonstandard parts for these capacitors for years. Original equipment manufacturers (OEMs) were either using the unproven commercial capacitors directly or up-screening them with additional testing in an attempt to ensure their reliability. The need existed to standardize the requirements for smaller higher-capacity capacitors with proven reliability.

Approach

Mr. Bonitatibus knew that a new ceramic chip capacitor specification allowing base metal electrodes (BMEs) would be the best way to help solve the problem by providing the needed capacitors. He formally started drafting the requirements for the documents with weekly WebEx teleconferences. The first teleconference was held in March 2013 with participation from the National Aeronautics and Space Administration (NASA), the Aerospace Corp., SAE G-11 and G-12 committees, capacitor manufacturers, microcircuit and hybrid manufacturers, and major OEMs. The teleconferences continued weekly until the final draft was agreed upon and approved. Mr. Bonitatibus was a major participant and contributor during the teleconferences, and he is still actively involved in the teleconferences to identify the details for three additional specification sheets.

MIL-PRF-32535 is the first military capacitor specification that allows BME in ceramic capacitors. Although commercial BME ceramic capacitors have been around for years, their reliability was unproven. No standard test or design criteria existed, time was needed for the capacitors to develop, the technology needed to be proven, and testing needed to be defined. The allowance of BMEs will enable this specification to offer higher-capacitance values that military and space users need. The electrodes in BME capacitors are nickel as opposed to the palladium silver that is used in precious metal electrode (PME) capacitors. Four manufacturers were eager to qualify the capacitors.

Mr. Bonitatibus ensured that standard-reliability products were included in the specification for applications that didn't require space-grade parts. The original desire of the committee was to create a military specification for high-reliability BME capacitors. The inclusion of standard reliability parts will make the parts a good fit for more applications, by alleviating costly requirements that are not required for non-space-level programs.

Conventional multi-layer ceramic capacitors contain PMEs. Manufacturers started developing multi-layer ceramic capacitors with BME over 15 years ago due to the high cost of palladium silver used for electrodes in PME capacitors. Palladium prices rose from around $100 per troy ounce in 1991 to more than $1,000 per troy ounce in 2001. The BME capacitors use nickel that is much less expensive. Manufacturers used standard testing requirements from PME capacitors in an effort to prove reliability of the BME capacitors. These requirements weren't ideal and didn't prove their true reliability.

The industry standard for ceramic chip capacitors is now BME, and new capacitors designed with BME have a much greater capacity. While the BME capacitors were evolving, Mr. Bonitatibus studied them, reviewed reports, and discussed the capacitors with groups since their early years. The manufacturers were reluctant to take the steps to create a new military specification and to qualify to it until the product was mature and the demand was high enough to justify the qualification cost. This specification will be a great benefit for the military and space customers.

Outcome

The new capacitors will provide the military, NASA, and industry with the reliable, higher-capacity capacitors needed for their missions. Military capacitors have not been able to meet many of the needs for smaller and higher capacity. The new capacitors will meet these needs and they are expected to be used in every future military and NASA system for many years.

Mr. Bonitatibus reviewed many nonstandard parts evaluations submitted for approval by OEMs for use in their systems during the past several years. The new specifications will help provide the needed capacitors and avoid the use of nonstandard capacitors. Nonstandard parts are typically more expensive, are harder to procure, are not as reliable, and become obsolete

and out of production sooner than standard military parts. Nonstandard parts also often contain pure tin finishes that promote tin whiskers that cause system failures. The new specifications will help meet the long system life of current military and space programs without the capacitors becoming obsolete and unavailable. These capacitors are also protected by the trademarked JAN branding to make them less susceptible to counterfeiting.

Mr. Bonitatibus' efforts support the needs of the military departments for standardization by providing reliable ceramic capacitors that meet performance needs. The end result will be thousands of new ceramic capacitors for use in demanding military systems. His efforts preclude the costly piecemeal introduction of nonstandard parts to try to achieve a similar end. The new specification is conservatively estimated to preclude a minimum of 50 nonstandard parts each year for the next 5 years. Based on the DoD Parts Management Program Model, this will result in a cost avoidance of $1.4 million annually ($6.8 million for 5 years). An added benefit of this new military specification will be the multiple qualified manufacturers for these capacitors that will result in supply availability for many years to come.

Current Status

MIL-PRF-32535 and 10 capacitor specification sheets were dated September 28, 2015. Mr. Bonitatibus is developing three additional specification sheets for interdigitated capacitors that will be used in hybrid applications covered in the hybrid specification, MIL-PRF-38535. He continues to provide support to the DLA Land and Maritime Sourcing and Qualifications Division and the four manufacturers interested in qualifying to the new specifications. Mr. Bonitatibus participated in the first qualification audit for MIL-PRF-32535 in December 2015. Because manufacturers need site audits and qualification requires a 4,000-hour life test, the estimate for manufacturers being qualified is by September 2016.

Challenges

There were many challenges in this project that Mr. Bonitatibus was able to overcome. Because there were no industry standard requirements for BME capacitors, a great amount of research and discussions was needed. Mr. Bonitatibus needed to encourage component manufacturers to support the new specification, work with the many manufacturers and users, come to a consensus on requirements, and resolve the hundreds of official comments from the draft documents.

Once the final drafts were ready, Mr. Bonitatibus sent them to the DLA Departmental Standardization Office for final approval as required by DoD 4120.24-M for new specifications that contain qualification requirements. He wrote a justification for qualification for this specification and received the final approval.

About the Award Winner

John Bonitatibus is the Defense Logistics Agency's capacitor expert and was a critical part of the development of this effort from the inception of the initial concept. He was an integral member of the working group that consisted of 45 members from NASA, the Aerospace Corp., SAE G-11 and G-12 committees, capacitor manufacturers, microcircuit and hybrid manufacturers, and major OEMs. He helped guide the group and keep them on track.

Mr. Bonitatibus' responsibilities in preparing for the new documents were many, including adding valuable input during teleconferences and meetings, requesting projects, generating and coordinating multiple drafts, consolidating comments and recommending their dispositions, resolving the comments, obtaining final approval for documents, and answering the many questions along the way. He also has the necessary knowledge of the requirements for military specifications. His expertise in DoD 4120.24-M (Defense Standardization Program Policies and Procedures) and MIL-STD-961 (Defense and Program-Unique Specifications Format and Content) was vital to the development and dating of these specifications. Mr. Bonitatibus took the very rough outline developed during the teleconferences and developed the full military specifications. He developed the qualification procedures and finalized the specifications. He prepared the justification for qualification and presented it along with the documents to the DLA Departmental Standardization Officer for final approval.