MIL-PRF vs. AEC-Q200
Do You Know What You Are Getting?

By Kevin Palmer, Sr. Director Business Marketing, Passives

SUMMARY

Manufacturers of commercial space and avionics systems sometimes turn to AEC-Q200 automotive-rated parts for non mission critical applications, as a way of balancing quality and cost requirements. When making this choice, however, they need to be aware that not all AEC-Q200 qualified parts are created equal; the standard defines test procedures while leaving acceptance criteria up to the user and the supplier. Therefore, when engineers are considering AEC-Q200 parts in non mission critical applications, they need to take a careful look at what each supplier is doing in terms of production processes, test conditions, test limits, and quality systems and certifications; this is the only way to have confidence that components will deliver the desired level of quality at the volume and level of specific testing required for the application.

THE BACKGROUND: HI-REL, COTS, MISSION CRITICAL, AND NON MISSION CRITICAL

As the use of electronics is growing in commercial space and avionics systems, there is a continued push to reduce costs and make components more affordable, particularly in higher volume non mission critical applications, or equipment that can be subjected to a regular service cycle or upgrade cycle to newer technology. To meet the overall increased demand and price pressures, component manufacturers have established high yield and high efficiency production processes, but they are predominately based on the requirements of the large volume commercial market. While these quality standards meet the requirements for the commercial market, they do not necessarily meet the requirements for the commercial space or avionics markets.

At the same time, the aerospace, military, and space (AMS) market has a need for products that provide consistently high performance in harsh environments over longer timeframes. Historically, this market has relied on very specific components that are manufactured to a defined military / space standard, mission profile, or MIL-PRF / DLA drawing. However, more recently some AMS companies have developed high volume commercial innovations like electric vertical take-off and landing (eVtol), unmanned aerial vehicles (UAV), low earth orbit satellites (LEOS), and other electronic warfare equipment. The specific requirements of these designs have challenged engineers to fully evaluate, and potentially consider, alternative-grade products to lower costs. However, even though these applications can be considered non mission critical and very budget-conscious, they demand significantly better performance and reliability than commercial-grade products due to the risk and consequences of failure.

A number of years ago, the military market explored the use of commercial off the shelf (COTS) components to reduce costs for non-critical applications. The problem was the lack of knowledge concerning the long term performance of COTS products. Since they were sold “as is”, they did not receive additional lot testing to identify their infant mortality failure rate, unlike products based on the traditional established reliability of MIL-PRF or DLA drawings. Engineers recognized a need for a product in between the quality of COTS and MIL-PRF, so some manufactures released COTS+ products that allowed engineers to select specific product testing based on the end application. COTS+ products have been successful, and have a place in the market, but are not widely available.

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UNDERSTANDING THE MEANING OF "AEC-Q200 QUALIFIED" AND "AUTOMOTIVE GRADE"

The rapid adoption of electronic applications in the automotive market has resulted in significant component developments to serve this sector. Under the hood applications have much higher temperature, temperature cycle, humidity, vibration, and sulfur resistance requirements due to their proximity to the engine and exhaust system gasses. At the same time, the high cost of failure in terms of recalls and potential liability requires lower failure rates and longer lifespans. With these performance levels, higher volumes, and long production platform timescales, the components are attracting the attention of the AMS market as potential alternative solutions for non mission critical applications.

Before assuming automotive products will meet the specific requirements of the AMS market, it is important to understand the automotive-grade specifications and quality standards behind them. Back in the early 90s, the Automotive Electronics Council (AEC) was established by Chrysler, Delco Electronics, and Ford to create a common part qualification and quality standards system. Originally, AEC consisted of two committees: the Component Technical Committee and the Quality System Committee, which is no longer active and deferred all quality specifications to IATF 16949.

For passive electronics devices, the AEC created the AEC-Q200 standard, which defines the minimum stress test driven qualification requirements and references test conditions. Once approved, production processes are tightly controlled to consistently provide parts manufactured to that agreed-upon standard, and they are also subject to a two-year qualification maintenance timeline. Testing procedures are well-defined within AEC-Q200, with sample sizes for test lots, but the specification notes that the measured parameters, values, and workings of each acceptance criteria for each test should be agreed upon between the user and supplier, rather than creating a specific standard for all producers. Why is this important? One supplier can define the acceptance criteria for an operational life test at ± 1 %, while another supplier can define the acceptance criteria at 5 %. Therefore, although manufacturers publish datasheets noting AEC-Q200 qualification, the actual parts are not necessarily direct and exact equivalents. Different production lines, manufacturing processes, and test methodologies can result in variations from supplier to supplier. This is especially true since manufacturers can define their own set of test limits to match their optimized production processes.

ALL AEC-Q200 QUALIFIED PARTS ARE NOT CREATED EQUAL

IATF-16949 is an important certification for automotive production and was created as the international standard for automotive quality management systems in production facilities. IATF-16949 emphasizes the development of a process-oriented quality management system that provides for continual improvement, defect prevention, and reduction of variations and waste in the supply chain. Importantly, IATF-16949 certification is **not required to produce AEC-Q200 qualified products**. As a result, there may be important differences in the components produced in terms of comparative quality, reliability, and performance, depending on the specific manufacturer.

Due to the harsh environmental requirements of automotive applications, the stress test levels for AEC-Q200 parts are very demanding and even exceed military standards in some areas. However, some military requirements, such as established reliability, have load-life testing up to 10 000 hours per part and cumulative test hours exceeding 96 000 000 hours in a twelve-month period (S failure rate), providing unrivalled performance / quality levels. The basis of AEC-Q200 relies on process controls in high volume manufacturing and a statistical base at the sub-ppm level to achieve reliability goals. By comparison, military products incorporate a series of part treatments, screenings under accelerated conditions, and a post-production quality gate for 100 % screening of production lots, in addition to process controls.

Another important consideration for use in high reliability applications is termination material. In commercial applications, tin / lead (SnPb) is strictly restricted. Most AEC-Q200 parts are similarly produced with pure SnPb-free terminations. However, some manufacturers can specifically offer SnPb terminations for AEC-Q200 devices to provide an alternative solution for the AMS market. This is especially important in applications that might suffer from tin whiskers. However, as this is only available on a few product series, and will be a much smaller production run, the cost for these components can be much higher than for standard lead (Pb)-free AEC-Q200 production parts.

CONCLUSION

Using AEC-Q200 parts in high reliability applications can potentially achieve the desired level of quality, but in some cases not at the volume or the level of specific testing required for the application. Engineers must evaluate their application requirements and environmental characteristics and should undertake an in-depth evaluation of each supplier in terms of their production process and product performance based on tests completed, conditions of the test, test limits for the product, and quality systems and certifications in place. All this information needs to be considered when selecting the most appropriate solution.