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Obsolescence, Counterfeiting and COTS: understanding the consequences

Introduction

In the last decade the obsolescence of electronic components including passive components such as resistors, capacitors, inductors as well as integrated circuits (ICs) has become a gray issue for many OEMs and design houses in the avionics, military and space (AMS) market. Many of the precision resistors and ICs that were designed into systems from the early 90s and into the beginning of the 21st century are, unfortunately, becoming obsolete or difficult to get for reasons beyond the control of these companies. The reasons can vary. They range from the rejection by specific industries of tin-lead terminations or pressure from purchasing and management to reduce the cost of the bill of materials (BOM), often by searching for substitutes from Asia.



Whatever the specific causes, the results have been quite negative. Many AMS suppliers have seen unintended consequences in their shift from traditional established-reliability precision resistors qualified by the Defense Electronics Supply Center (also called DSCC) to commercial-off-the-shelf (COTS) resistors. Pressure to reduce prices has actually hastened obsolescence and counterfeiting while encouraging some manufacturers to publish less definitive datasheets that mask the very real differences between their low-priced products and military-qualified devices with full supportive data. The OEMs can mitigate the confusion with the only solution that really works—taking the time to verify the history of the precision resistor manufacturers, confirm the truth and availability of the technical data and support they provide, and order samples for testing as needed.

For a few decades the AMS customers drove the market for high-precision resistors and provided the impetus to develop more compact resistors with multiple levels of documented reliability. The warranties for these products pledged long-term availability as well as very high performance levels. When these AMS customers started driving designs towards the use of COTS parts, the manufacturers responded with equal enthusiasm. Unfortunately, that process became the foundation for a burgeoning growth of counterfeit components that has become a serious problem in the industry—placing contracts, reputations, and even lives at risk.

Origins of the problem

In the 1960s, the start of the exponential growth of electronics in military systems, communication satellites, and space exploration brought about the need for specific base-line performance standards for high-reliability components. Design engineers needed to be certain that components would perform the exact same way with known reliability regardless of manufacturer. That was the only way to be sure that systems operated the same way over different life cycles. It also ensured that replacement parts could be used without changing fundamental performance criteria and with no reduction in reliability.

Beyond standardizing performance, military specifications specified the testing protocols underlying the data used in statistical analysis to define various levels of reliability. Any manufacturer who qualified to these specifications and maintained the continuing testing could supply parts against these specifications. All manufacturers who qualified were considered to be equal. Different specifications were issued for different technologies to avoid distinctly different characteristics within the same specifications. If one manufacturer had a unique product with far superior performance he could only qualify to the lesser performance levels of the established specs - which were highly influenced by the common performance levels of multiple manufacturers. Applications that needed the superior performance levels still had to write separate specifications to define the critical performance parameters.

Eventually, Mil-R-55182 was amended to add the RNC90Y and RNC90Z (Z-Foil technology) resistors and this eliminated many of those extra separate specifications. But space applications among other applications still demanded parameters that were not included in the military specifications, and users continued to write special source-control drawings (SCD) to get exactly what they needed.

Military qualified components came at an added cost. Qualification and maintenance were an expensive burden on the manufacturers and they had to be included in the component price. The cost burden included qualification and maintenance testing, administration and reporting costs, equipment and QC costs, and the cost of the tens of thousands of components whose lives were used up through the test protocols.

As the use of qualified parts expanded into nearly every military and space project, the quest for new systems and extraordinary performance began to be moderated by the need to reduce the cost of the required components. So interest developed in using standard commercial components rather than fully qualified parts. Eventually these became known as commercial-off-the-shelf or COTS components.

COTS components are less expensive because there are no uniform tests and documentation protocols as there are in the military specifications. Suppliers no longer have to be on the Qualified Suppliers List (QPL). It is highly desired that a supplier have the experience and background to support a QPL program but it is no longer a requirement. As a consequence, price considerations have begun to dominate design decisions. Manufacturers' claims become less controlled by objective standards and even datasheets become more of a reference than a guarantee, providing a looser interpretation of specifications. Before long, deception by omission and incomplete descriptions begin to creep in.

Designers can now mix component technologies in the same applications even though different technologies have different defining characteristics. Precision resistors, for example, may have the same resistance value and tolerance but vary widely in temperature coefficient of resistance (TCR), power TCR (PCR), thermal EMF, current noise, ESD, and end-of-life cumulative deviations (or total error envelope), none of which is automatically included in the resistor's identification by value and tolerance. Replacements or substitutions are made by form, fit, and function (FFF). Resistors are then purchased to fit the equipment's initial function, ignoring the performance and reliability effects of the other, unmentioned, characteristics. Data from which to make statistical predictions regarding failure rate or mean-time-to-failure (MTBF) is lacking. COTS also presumes that replacement parts are available when needed. It presumes continued supply by the manufacturer. If the manufacturer discontinues a product

the “off-the-shelf” part of COTS evaporates and new problems arise, to be subsequently discussed in further detail.

With established-reliability (ER) and EEE-INST-002 components, all critical performance characteristics were specified and demonstrated along with documented reliability. With COTS, the design and purchasing decisions are focused on price, manufacturer claims, and BOM costs. Equipment reliability becomes separated from parts and production costs. Purchasers are encouraged to buy from the cheapest source, equipment reliability is no longer linked to parts purchased, and repair costs increase along with field failures.



EEE-INST-002 Bulk Metal® Foil resistors

New sourcing problems

We now must recognize that “commercial” is an important part of COTS. Commercial suppliers make economic decisions. Parts may be discontinued. Suppliers may cater to the majority of their customers who demand lead-free terminations and neglect those that need tin-lead terminations. They may discontinue the tin-lead versions or, at least, make them only when ordered (and there goes the “off-the-shelf” aspect of COTS). Moreover, the manufacturer is free to change processes without having to prove equal performance and reliability. This is done with minimal relation to form, fit, and function, not reliability.

When a supplier decides to cancel a product it becomes obsolete. The manufacturer might offer a limited time for users to make a lifetime buy for specific parts. But even if the OEM can predict his expected usage, he has no backup for an unexpected revival of customer purchasing or for new equipment using the same circuit boards. Additionally, parts remaining on the shelf for extended periods of time suffer deterioration of solderability, moisture intrusion, contamination, and oxidation. The lifetime buy products will also all have the same aging date code while many of the OEM’s customers have date code restrictions, limiting their use sometimes to one year and almost never more than two years.

Now the OEM must either design in a new resistor involving costly analysis and possible requalification of equipment or identify a source for the discontinued precision resistor. The latter path often leads to counterfeiting. The buyer searches through distributors. The distributors search through specialty suppliers or even brokers. The specialty suppliers search through unregulated and unreliable sources, often in Asia. The unregulated sources seize on the opportunity; they begin to counterfeit the needed parts and sell them at a large mark-up under the camouflage of the lengthened supply chain back to the desperate OEM. Field failures increase. Reputations, and possibly lives, are at risk.

Counterfeiting usually depends upon greed or even deliberate deception somewhere in the supply chain. Investigators of failed military components have found that almost all failures were traceable to counterfeit parts. Further, their investigations have uncovered huge factories in one Asian country where the factory was actually segregated and labeled with large organizational signs identifying what specific manufacturers' parts they were counterfeiting in each section.

In one incident the buyer for a very well-known aerospace company had forgotten to buy precision resistors for a military satellite that was due for launch within a month or two. The resistor specification required strict lot controls and very extensive group A, B, and C testing, with parts not usable until successful completion of a 10,000 hour load life test. Obviously, there was no way to manufacture, screen and test the resistors to meet the launch date. Fearful for his job, the panicked buyer attempted to convince the manufacturer to provide prototype-processed resistors against the purchase order for the specified parts with no lot controls, unapproved manufacturing processes, and no screening or testing. Essentially, he was asking the manufacturer to counterfeit his own hi-rel resistors. When the manufacturer refused, the buyer's response was: "Look, if the satellite fails it will be in outer space where no one could determine exactly what caused it to fail." So, here we had a company with all the proper quality and supply chain controls but with a buyer willing to subvert it all and risk failure of a satellite of unknown, and possibly life-critical, purpose for his own personal financial security.

Summary

It is critically important for designers, component engineers, and designers to know their component manufacturers, their product commitments, their integrity, their reputation, the specific details of their products, the design and test links of their commercial products to their reliability-documented products, and to never, ever allow any unapproved links in the supply chain. Faced with the continuing concentrated ingenuity of the counterfeiting entities, everyone must protect themselves and the industry, in general, with scrupulously unrelenting vigilance and supply-chain control.

Further information about Vishay Foil Resistors products is available at: www.vishayfoilresistors.com

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