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Guidelines for Use of COTS Passive Parts in Military Systems

Passive parts are a necessary component of all electronics circuits in military systems. Passives are defined as capacitors, resistors and magnetic components (transformers and inductors). Electromechanical relays, quartz crystals and fuses are also sometimes considered in the category of passive parts. Passive parts encompass a wide range of technologies, materials and manufacturing processes. This is why it is difficult to apply a general set of rules to all passive parts but some general guidelines do apply to the use of commercial passives and these will be discussed here. The technologies are for the most part mature, however some notable changes have occurred or are occurring in passive parts. Surface mount has brought about significant emphasis on miniaturization. Capacitor and resistor chips as small as 20 mil by 10 mil (the size of a pencil point) are commonly used in commercial applications. Packaging for surface mount passives is non-hermetic and plastic packaging is used extensively. This can lead to concerns for tolerance to environmental effects, particularly during assembly on circuit boards. The reflow soldering and cleaning environments can be among the most adverse conditions a part will see in the field. Latent defects introduced at this point are of particular concern. Passive part reliability is generally very good however and significant class problems are rare in the field.

Commercial passive parts are defined here as any non-Mil-Spec or non-Mil-drawing part. Since commercial applications are so varied, the type and quality of commercial passive parts also vary. Product offerings typically include consumer, industrial, automotive and medical grades. The quality/reliability level between the commercial grades can vary considerably as can the cost and availability. In general, passive suppliers do not recommend consumer grade passive parts for high-reliability military applications. On the other end of the spectrum, many vendors claim the parts they supply to the medical industry are as good as if not better than Mil. Some very good test/screening methods have come out of high-end commercial product lines.

Commercial passives can offer significant advantages in size, cost and availability. Many are available in extended ranges of value and rating. These characteristics offer obvious advantages to circuit designers where high performance, size and weight are concerns. Many, but not all, COTS passives are built on the same manufacturing lines with the same raw materials as military parts. However, they tend to have less lot traceability and pedigree is more difficult to acquire with commercial. Cost is the other significant advantage for commercial-grade passives. Cost differential between military and commercial parts range from 5X to 100X. And while the cost of commercial continues to come down, as competition is always a factor, reduction in the use of military parts has frozen or increased their cost. This reduction in use also increases the risk of part obsolescence.

Commercial passives are a good fit for many military applications however it is important to understand some of the significant differences between the product lines. In general, much less testing is performed on commercial product. This can be particularly

prohibitive in the area of screening tests such as burn-in, which is rarely done on commercial-grade passive parts. Supplier selection becomes even more critical since no approved source lists exist as in the military. Dependent upon the product sector, quality variations between suppliers can be significant. Quality indicators such as ISO are important to watch for when selecting sources. One of the most common mistakes made by OEM's is making source selection based primarily on cost and delivery while leaving out a good technical assessment of the supplier's quality rating. Component engineering as a part of new equipment design is much more relevant than ever before. The parts management programs used on military programs in the past, though somewhat outdated, are essential in some form in order to make good decisions about part and source selection. In general, there are fewer passive component suppliers than there once were. Consolidation in this market sector has been significant in the last several years. Reduction in the number of suppliers has been even more acute in military parts since there are not only fewer suppliers but many previous approved sources have discontinued their military approvals. Many suppliers are now also manufacturing part or all of their products off shore. This is also true with military parts since there is no longer a prohibition on offshore JAN production.

The passive industry is undergoing significant technological change, particularly in the capacitor area. Both ceramic electrostatics and tantalum and aluminum electrolytics are experiencing significant changes in materials and manufacturing processes. These new product technologies are not making their way into military product lines. Reliability testing, which has traditionally been performed for military products and has benefited the commercial equivalents, is no longer performed. This leaves reliability demonstration for the new technologies up to the manufacturer, or to field experience. Neither of these methods should be considered good enough for mission critical, high-reliability military applications. Having good knowledge of and a good working relationship with the passive part suppliers is an essential prerequisite to having quality passive parts that perform acceptably in military applications.

Another significant change that is occurring not only in passive components, but across the commercial electronics industry is lead-free solder systems. Passive manufacturers are either converting or have converted the terminations of their commercial products to lead-free. In most cases the solderable terminations are pure tin. Use of pure tin re-introduces the potential for electrically conductive, tin whisker growth. This failure mode has been responsible for the loss of millions of dollars worth of military and aerospace hardware. Lead-free alternatives to pure tin are few and usually require significantly higher soldering temperatures. This raises yet another issue with potential of thermal damage to sensitive components.

Acceptance of commercial passives for military systems is completely dependent on the application and expected performance. Non-mission critical, environmentally benign Mil applications are a good fit for COTS passives. Mil or space level passives continue to be best for high reliability and/or environmentally severe applications. All applications in between depend on performance and reliability expectations of the system.

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PASSIVE PART SUGGESTIONS:

- Choose vendors and part grades to meet the application. Look for ISO9000 certification for vendors, and check into the level of part quality screening performed on the parts being considered.
- Non-hermetic plastic packaging is used extensively by both military and commercial grade suppliers, but reliability in general has been good. Hermeticity is usually available only in leaded packages, not surface mount.
- Full-military spec parts cost 5x to 100x that of comparable commercial-grade parts. Use them only when requirements indicate.
- Most suppliers focus on commercial-grade passive parts. Selecting a different grade (high-reliability, or military spec) may lead to increased component obsolescence issues.

Passive Components Comparison

Commercial Grade	Comparison Area	Full Mil-Spec
Shrinking greatly	Physical Size	**Larger than commercial, but shrinking**
Limited electrical, usually no burn-in	Amount of Testing	**Burn-in, extensive physical & electrical**
Wide variation among vendors and part types	Quality Variation	**Must meet minimum standards, little variation**
Numerous suppliers, some market consolidation	Number of Sources	**Few and losing vendors every year**
On & Off-shore	Manufacturing Location	**On & Off-shore**
Less than 20% of the price of Full-Mil	Price	**Relatively high**