RF Packaging Advancements for Navy Applications

The vast majority (99%) of the electronics market in North America is composed of products produced for commercial applications. The 1% share of the electronics market driven by Department of Defense (DoD) applications has created a niche market for RF qualified devices.

The DoD, with its emphasis on COTS (Commercial Off The Shelf) and "Open" systems, is beginning to become more interested in using commercially oriented RF devices for military applications as a means to leverage the volumes and innovations of the commercial world.

Reliability is the subject of prime importance to the EMPF in the use of these commercial breakthrough RF technologies, since the commercial products are often not as rugged as required for the military uses. While RWOH (Reliability Without Hermeticity) may work in the commercial world, it has often not been tested for military systems.

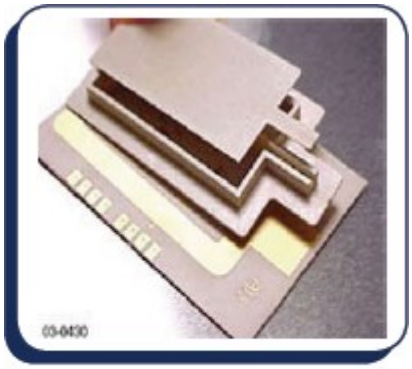

Figure 2-1 Foster-Miller LCP based RF circuit board and hermetic enclosure shapes (courtesy of Foster-Miller and Quantum Leap Packaging)

The newest RF innovations are the ones that are now almost routinely used commercially in cell phones, wireless enabled laptops, RFID tags (for everything from retail shoplifting prevention to livestock identification) and automotive radars, to name just a few. To the extent that these commercial RF products can be made to defer the obsolescence and/or enhance the features of a military system, they are of potential military value.

There is also a niche market for the long standing "hermetic" electronic package within the military. Historically, hermetic packages, having glass to metal seals and no plastic components, have been used in military systems. Their track record of reliability under harsh conditions is proven.

Expensive re-qualification of any military electronic package, which would be required when it is replaced with a generic, non-hermetic plastic electronic package, is never an attractive option. This is true even though the plastic package represents a less costly, smaller, and lighter alternative to the heavy, costly hermetic ones.

Because of both the potential RWOH advantages of plastic packages, and the prevalence in the DoD of legacy hermetic electronics concerns, the EMPF is in the process of installing both true hermetic and "near hermetic packaging facilities. The new Power Packaging Lab will allow both the fabrication of conventional hermetic (glass to metal sealed) and the lighter, smaller and less costly near hermetic (plastic)electronic packaging. This will provide the opportunity to compare the technologies and optimize Navy electronic systems in RF, digital, and power electronics within a single facility.

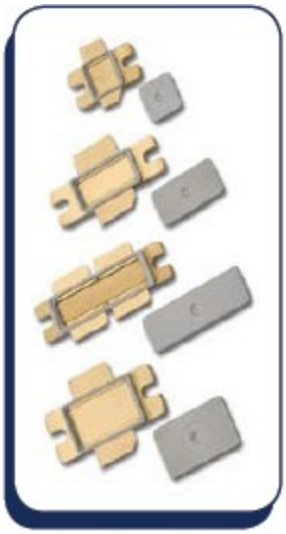

Figure 2-2 Quantum Leap LCP RF power packaging products for commercial/military applications (courtesy of Foster-Miller and Quantum Leap Packaging)

The premiere equipment for the RF packaging part of the job will be the DataCon die placement machine. This machine will be capable of placing bare die, either into a true hermetic metal and ceramic package, or into a near-hermetic plastic one. Subsequent electrical and environmental testing at the EMPF will enable validation of the RWOH concept in military applications. Some applications may be shown to still require the extra weight, size, and cost of the truly hermetic package. When this is proven, the true hermetic package can be optimized. However, in the cases where the less costly, near hermetic package proves viable in accelerated life testing (using the true hermetic package as a "control"), major cost reductions will be possible.

Complete facilities for creating certified hermetic packages, with package cavity lid sealing, and gross and fine leak testing, are included in the laboratory equipment. This will enable the packaging of the same RF, or other electrical functionality, in a truly hermetic enclosure, and through environmental testing of the finished package, compare it to the plastic equivalent.

For the near-hermetic materials of choice, the Liquid Crystal Polymer class of plastic materials is commercially available in both RF, power electronic, and printed board laminate forms (See Figures 2-1, 2-2). These materials are the most likely to enable RF near hermetic packages to fulfill the application requirements usually assigned to their hermetic counterparts. Using the EMPF Power Packaging Lab, the differences between the two in the application can be evaluated precisely. Methodologies to allow use of the less costly, smaller, and lighter plastic packages can then be developed.

Property	Typical Ceramic	Liquid Crystal Polymer
Dielectric Constant	9.7	2.9
Dielectric Loss Tangent	0.009	0.002
Heat Deflection Temperature, °C	>1000 °C	270 °C
Cost per sq. in.	Approx. $10	Approx. $2
Water Absorption	0.0%	0.025%
Density grams/cu.cm	4.0	1.2
Hermetic (MIL -STD-882)	Yes	Yes

Table 2-3 RF and other physical properties of the hermetic ceramic and near-hermetic LCP

RF properties of the Liquid Crystal materials appear in Table 2-3. The dielectric constant is lower than ceramic, but can be compensated in the design of the RF circuit. The important RF properties of the Liquid Crystal Polymer of dielectric, loss tangent and water absorption, can be seen to be the near equivalent of ceramic at a much lower cost & density.

The EMPF Power Packaging laboratory capabilities described here will enable the comparisons of the many state-of-the-art power electronics packaging materials and designs that are contenders for Navy applications. This facility will then help the EMPF ensure that the most effective and affordable power electronic systems are chosen for integration into the Navy fleet.

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