MANUFACTURING WITH EFFICIENCY

THE LEADLESS CHIP CARRIER (LCC) AND MILESTONES OF LOW COST THERMAL DETECTOR PACKAGING

DRS Technologies
Commercial Infrared Systems

DRS Technologies
A Finmeccanica Company
DRS Technologies is a leading provider of thermal sensors for the military — a sector that often demands the highest performance and reliability available, with price being a secondary or tertiary consideration. When it comes to creating sensors for the commercial marketplace, however, cost moves to the forefront of a typical product engineer’s considerations. To meet the needs of a broadening commercial marketplace, it was clear to the DRS development team that a new approach to creating vacuum packaged sensors would be required in order to compete for inclusion in products that retail for hundreds of dollars instead of thousands of dollars. The solution: Leadless Chip Carrier (LCC) production in larger manufacturing lot sizes.

A Clean Slate

LCC packaging uses economical materials and other commercially available components and processes to achieve a lower-cost solution when compared to military-grade detector production. In the commercial marketplace, exceptional performance and optimized size are vital components of a successful product, but there is less necessity for a ruggedized solution as required by defense applications. Which is why, in 2010, DRS designers began with a clean slate and asked the question, “How can we build a detector that is worthy of the DRS heritage of detector performance, reliability, and image quality, with cost being the primary consideration?” This may seem like a natural place to start with a project of this nature, but with DRS’ history of defense program wins the primary question had always been, “How do we keep the warfighter as safe, equipped and prepared as possible, regardless of cost?” Therefore, this simple change in focus required a new perspective for DRS design personnel.

The initial process involved reaching out to suppliers for consultation on leveraging existing materials and processes in order to cut costs to a bare minimum while maintaining category-leading product performance. This process took three forms.

First, the development team evaluated different materials for both the “window” and the “carrier” components. These included silicon, ceramic, metal and other materials.

Second, an internal manufacturing and assembly process inspection was conducted with the intent to reduce the number of process steps required to produce comparable product results.

Third, production was streamlined and processes were combined in an effort to mirror commercially developed applications as closely as possible.

LCC Vacuum Packaging — an Innovated Approach to Cost Savings

LCC Vacuum Packaging is a manufacturing solution for constructing detectors that achieve DRS’ design goals of streamlining, eliminating and combining process steps by utilizing a unique sealing technique performed in large lot sizes instead of processing
detectors one unit at a time. In detector manufacturing, the most critical and time-consuming step is the effective evacuation of the enclosed package under a constant and very tight vacuum. Keeping air and contaminants within the package to an absolute minimum is vital in producing a functional and reliable detector. In traditional detector packaging — most often used for high-end military imaging products like the DRS Driver’s Vision Enhancer (DVE) project which allows HMMWV and MRAP drivers to see through smoke, dust storms, fog, or complete darkness — the process of evacuation is performed by pulling a vacuum through a metal pinch-off tube attached to a specially designed vacuum pump. This process is performed one detector at a time and is extremely time-consuming. The LCC package process is very different. Packages are evacuated and sealed using a vacuum oven developed by DRS that is able to process multiple detectors at a time. Since the entire oven environment is under a vacuum, no pinch-off tube is required.

In addition to processing multiple detectors in a large lot size, other cost savings have been realized. The LCC process uses a low-cost, hermetically sealed, ceramic package that is commonly used in a number of commercially available electronics such as common DVD players, game consoles and televisions.

Another cost savings is realized in the absence of leads. As the name suggests, Leadless Chip Carrier (LCC) packaging does not require the thin, metal leads used in traditional detector assembly packages. This reduces the cost of the package in two ways. First, the LCC design eliminates the cost of the lead itself from the final product. Second, without the delicate metal leads this design removes the possibility that such connectors may become bent or broken, which dramatically reduces waste and replacement costs. LCC also allows customers the flexibility of mounting the detector packaging using a surface-mount soldering process, or a low-cost commercially available socket, pre-soldered to a given circuit board — common practices in printed circuit board assembly.

**How the Numbers Break Out**

The economic implications of this practice are significant. Historically, the detector had been the most expensive component in a typical thermal imaging camera — comprising as much as 35% of the total cost of a finished product. With such a large factor of influence over the end unit price of a product offering, reducing the cost of the detector better positions DRS to compete in the broader commercial marketplace.

LCC packaging using large lot size processing has resulted in a 40% reduction in the cost of the sensor when compared to the traditional military sensors. As a result, the electronics, optics and other components of a thermal camera have become the primary cost drivers. An important distinction as DRS seeks to further its market accessibility by producing commercial products at even lower price points.

**Military Performance Not Required**

The expense associated with military grade detectors can be attributed, in part, to the tasks that they were built to perform and the requirements of those tasks that exceed those of a commercial application. They need to be made to withstand the severe shock and vibration that one might encounter in a military vehicle or when mounted on a soldier’s weapon. They need to survive in an environment of high explosives and extremes in temperature. Essentially, military grade detectors are asked to provide a level of performance that is commensurate with the gravity of the task at hand.

Commercial applications for thermal detectors may include security and surveillance camera systems, predictive maintenance, automotive operation, medical imaging devices, traffic monitoring, or UAV and UGV implementation. While these use cases demand exceptional image quality and performance, they do not require a package designed to withstand the shock and vibration of explosives or gun fire.
A Delicate Cost/Performance Balance

While cost was a predominate consideration in the development of this new detector manufacturing process, it was imperative that the DRS design team develop a final product that offered a level of performance and reliability consistent with DRS’ heritage. As a result, engineers embarked on a systematic testing exercise to discover the appropriate balance between cost and performance.

A series of rigorous verification tests were executed on the prototypes to ensure that the vacuum life — a critical metric for detector performance — was consistent with the standards set by our traditional detectors. The development team continued to weigh the resulting data of the detector response relative to the detector voltage. When DRS quality and reliability criteria were met, the results yielded a LCC detector capable of operating with a vacuum life that far exceeds industry requirements, ensuring that a given thermal camera would likely become obsolete before it fails.

Hands Off Triumphs Over Hands On

Entering into this process, the DRS design team held one significant assumption about detector manufacturing: “If we can reduce the amount of time during production that an operator needs to touch a unit, we will reduce the price.”

And in the end, this assumption was proven correct. By streamlining the process, removing or combining steps to lower the total number of touches, and designing a large lot size process, as opposed to individual processing, the most significant cost savings were realized. The process relies upon proprietary equipment designed by DRS engineers to be fully automated, precisely controlled and capable of delivering high assembly yields.

Ultimately, DRS’ strong roots in the development of high performance thermal sensors for the warfighter offered a unique vantage point that would lead DRS to set higher standards when evaluating commercial product offerings. It is not enough to be a low-cost provider. A product baring the DRS Technologies name must meet performance requirements that mirror the values and principles of the quality inherent in its military grade products. LCC packaging and the expansion into commercial markets is a direct result of DRS’ commitment to a legacy of high standards and continuous innovation - providing an optimal balance of reliability, performance and cost.