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Extending the Life of Mission-Critical ICs

The small volumes on the military market are a mismatch to the high volumes and fast lifecycles that drive the semiconductor industry. Military system designers must look to specialist vendors and redesign options to keep pace.

By Edwin Slipher, QP Semiconductor, Inc.

Military-grade systems pose significant product lifecycle challenges. Military electronic components are simply not used in the volumes that commercial components are used. Personal computer and mobile phone manufacturers routinely deal with 10-million-plus product runs; but even high-volume military electronics, such as soldiers' personal radios, are sub-million quantities. Many programs have production runs in the tens to hundreds.

As long as military needs can piggyback on commercial production, parts are available. But commercial electronics products go through rapid product lifecycles. For instance, most computer products have six to nine month lifecycles and are essentially useless after three years. Short lifecycles in the commercial sector mean that certain ICs can be out of production—in other words, obsolete or EOL (end-of-life)—before the end of the military product lifecycle. Sourcing replacement ICs for these systems five, ten or twenty years down the road becomes a major challenge.

A requirement for a hand-held GPS or pocket calculator is an excellent example of an application where a commercial-grade product makes sense. Put bluntly, if the item fails, you buy a new one. There is no need for a repair depot, parts supplies and so forth. In comparison, an electronics system designed to be bolted into a combat platform, where field failure may cost lives, presents a different challenge. With the strict requirement of certain ICs that may now be obsolete, replacements simply can't be purchased commercially. The use of commercial ICs in such a product may be justified in some cases, but it presents significant cost burdens in ensuring long-term spare availability.

Fab Obsolescence

What is even worse than part obsolescence is fab obsolescence. Semiconductor companies have no manufacturing economic incentive to keep old fab lines operating. Costs are high and product demand is low. The fab machinery itself is out of production and becomes hard to repair. Nor can new fab lines run old processes. To do so, new masks are needed and a fab line that has been optimized for 300 mm wafers and a 130 nm process cannot manufacture the "huge" geometries of old processes measured in multiple microns.

In short, it's just not economical to keep exclusive military parts in long-term production. It's not easy to re-make them at a different fab either. Engineers who want to use commercially derived products in military systems should evaluate all of the issues and how they will play out during the total projected utilization life of the military product.

Planning for IC Inventory

There are two sides to the problem. A military OEM who needs spares for an existing program is on the reactive side. And another military OEM who is planning a new program is on the proactive side. It's important to consider both sides and what the options are for each.

For new programs, vendors should look carefully at the pros and cons of sourcing commercial parts. In a perfect world a simple solution would be to purchase and store enough inventory to meet the forecasted needs over the expected life of the product. This is hardly a practical solution given government procurement policies. Therefore, vendors must look elsewhere for alternative solutions.

Options for Sourcing Obsolete/EOL ICs	
1. Find original parts.	Surprisingly, there are lots of old parts stored away in warehouses and supply depots. WWII-vintage new-in-box parts are still out there, as well as newer components.
2. Find original die.	Military contractors often buy bare die rather than packaged parts. When properly stored, bare die have a virtually infinite shelf life. Again, military specialty IC vendors can assist in both finding such die, and handling the packaging and test requirements.
3. Find other parts or die.	Parts made by second sources not originally qualified to supply parts for the particular product in question. However, in almost all cases, such parts will have to be formally qualified for the application, a potentially expensive task.
4. Re-engineer at some level.	Redesign in a way that eliminates the need for the unavailable part. This can occur in several ways: a. Design a replacement IC that can be manufactured in a current process. This is feasible with reasonable volume. The non-recurring engineering (NRE) cost has to be absorbed within the current year of production, in most cases, or funded separately by procuring activity. And naturally a re-qualification should be performed. Note also that multi-project (a.k.a. multi-die) wafers can make this cost-effective even at small volumes. b. Adapt a different component or process. c. Redesign the board to eliminate or replace the missing component. d. Redesign the system to replace everything.

Table 1

When supporting older designs, there are basically four strategies military OEMs can follow when faced with a need for obsolete parts. They are listed here, in order of preference.

This is where specialty IC manufacturers come into play. Military specialty IC companies meet stringent government quality manufacturing regulations and can advise and assist with issues of long-term storage of ICs, bare die or wafers. This sounds expensive, but it is highly cost-effective when compared to the costs of re-engineering components or systems years down the road. Table 1 explains the four strategies military OEMs can follow when faced with a need for obsolete parts.

Pros and Cons of Redesign

Component redesign is possible. Most ICs, however, have subtle process-dependant timing and parasitic characteristics that may not be documented. A redesigned part can be different in subtle ways. But if care is taken in the redesign, the differences can be eliminated or reduced to the point that the applications cannot detect them (Figure 1). Whether the design works in the system may be determined more by the system itself than by the initial specifications. Companies should select vendors who are willing to work through design issues to a satisfactory result.

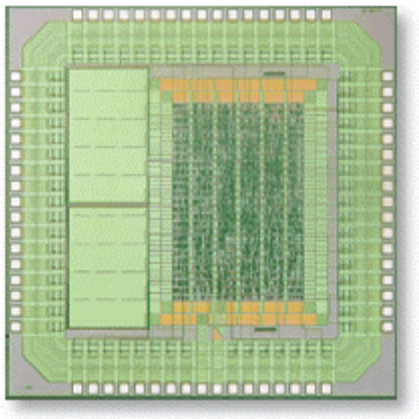

Figure 1

This QP Semiconductor part, QPALU, is an example of a redesigned ALU.

The biggest advantage of a system redesign often lies in the ability to eliminate more than one hard-to-find component from a system (Figure 2). In some cases this can be invaluable. However, the cost of formal re-qualification is significant in both time and dollars, with no absolute guarantee of success.

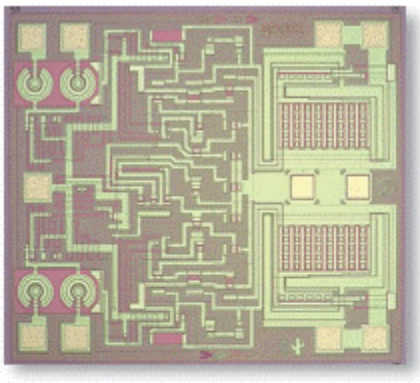

Figure 2

This QP Semiconductor part, the QP163x, is a redesign from a multi-die wafer: one device integrated from four.

In most cases, planners should allow time and budget for re-qualification. The type, level and cost of a re-qual will vary with each application, but unless a vendor is fortunate enough to find military parts from the original approved vendor, and with a traceable history, some level of re-qual will be required.

Vendor Selection

Specialized military-qualified vendors have entered the market to assist companies in finding and packaging die for these applications. Semiconductor companies usually offer lifetime buy opportunities for most products, but such an opportunity is neither guaranteed nor legally required. Variations in yield, fab shutdowns and other factors mean there may not be an opportunity for a final buy. For example, this April and again in August, National Semiconductor made five part numbers “no longer available” without offering lifetime buys (DS1691AJ, CLC402 MD8, CLC402 MDS, CLC420 MDC and CLC426 MDC).

Planners should consider working with a specialty military vendor to acquire sufficient stock before it is too late. By stocking up on mil-qual die as well as packaged parts, these specialty vendors can adapt to meet your needs. What should you look for in such a specialty vendor? First and foremost, experience. Vendors who have been in this business for years know the process better than recent entrants. Second is military qualification in IC fabrication, packaging and test. Lastly, experience in the proper storage of wafers and bare die. They last virtually forever if properly stored, but can be rendered useless by improper storage.

In short, the best strategy is to plan ahead. Regardless of component sourcing philosophy, ICs don’t stay in production forever. Semiconductor manufacturers are often unaware that parts are being used in military applications and therefore have no incentive to announce a pending EOL other than to their primary market base. You need to plan for this eventuality. And you want a partner who has experience in multiple solutions so you can choose the best for your design requirements.

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