Commercial Plastic Microcircuits – A Total Solution For Military Applications?

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Introduction

In 1994, a paradigm shift occurred in the military community with the release of Secretary Of Defense William Perry's directive that instructs military contractors, in general, to use performance based specifications in place of Mil-Specs. While almost all OEMs have embraced the spirit of the "Perry Directive", several misconceptions still exist regarding acquisition reform and the use of commercial off-the-shelf (COTS) plastic encapsulated microcircuits (PEMs) in military applications. This paper will highlight issues that should be considered by the OEM using PEMs in military systems instead of ceramic military components.

The Perry Directive

The "Perry Directive" states in part "...We are going to rely on performance standards ... instead of relying on milspecs to tell our contractors how to build something... There will still, of course, be situations where we will need to spell out how we want things in detail. In those cases, we still will not rely on milspecs but rather on industrial specifications [i.e., non-government standards]... In those situations where there are no acceptable industrial specifications, or for some reason they are not effective, then the use of milspecs will be authorized as a last resort, but it will require a special waiver."

The confusion with respect to the "Perry Directive" stems from the definition of industrial specifications and performance standards. MIL-PRF-38535, which defines the Qualified Manufacturing Listing (QML) system, is approved as a performance based specification by the Department Of Defense. Therefore, QML devices are by definition standard components just as are commercial plastic devices. It should also be noted during any discussion of the "Perry Directive" that it does not mandate the use of commercial components. Dr. Perry did not say use parts outside the manufacturer's specifications. Common sense, of course, dictates systems must meet mission and user needs.

Plastic COTS Components – Pros And Cons

The primary driver for the use of COTS components in military applications is low initial cost. In addition to cost, OEMs often cite these advantages to COTS components:

- Proven performance in commercial applications
- Broad initial product offerings
- Less board space required for SOIC types
- Lighter weight
- Less susceptible to physical damage, e.g., mechanical shock and vibration

The major disadvantages to using commercial components are attributable more to unknowns – There is limited data supporting long term performance in military applications. Due to the commercial market driven short product life cycles, the obsolescence issues have not yet been resolved. In addition, the following items should also be considered:

- PEMs are best suited for controlled environments, for example, low moisture and applications not requiring long-term storage or extreme temperature cycling.
- Commercial devices are typically not modeled or designed to meet military performance requirements unless a defined military component market exists up front for a specific supplier.
- Commercial devices are primarily characterized for 0 °C to +70 °C range with industrial grade screening -40 °C to +85 °C available as a limited option.
- OEM upscreening may be required to ensure device operation over -55 °C to +125 °C. Supplier test programs for complex devices are considered proprietary and are not disclosed.
- Package reliability performance varies from supplier to supplier and often from device family to device family from the same supplier.
- Due to the low volume of a typical military account when compared with a commercial account, there will be a lack of direct supplier technical support.
- Leading edge technologies are being designed for use with 3.3-volt power supplies that may not be compatible with retrofits to existing military applications.
- Specialized component handling is required for PEMs. This includes proper long-term storage of stock parts and the compatibility of palladium lead finishes with current military board mount solder processes.

Obsolescence Issues

Commercial component design is driven by performance oriented commercial dedicated applications. For example, DSP chip sets are often designed for telecom or hard disk drive applications. This practice can result in a commercial product spectrum driven by specialized devices for major commercial markets that do not easily integrate into military applications. Commercial product availability is driven by commercial market demand for leading edge components and applications. The obsolescence drivers are summarized in the table below:

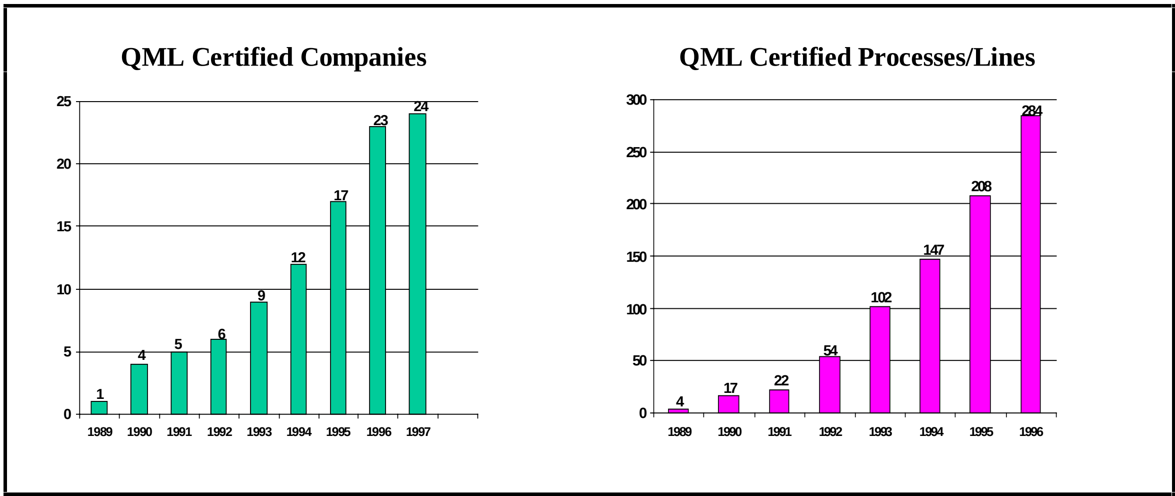
Market Segment	Primary Drivers	Secondary Drivers	Tertiary Drivers
ASIC	System life cycle	New technology	Wafer fab upgrade for technology
Microprocessor & DSP	Performance	Technology/lower cost alternatives	Obsolete process/wafer fab upgrade
Programmable Logic	Density/Performance	New architectures	Technology availability
Mixed Signal & Logic	Decreasing demand	Wafer fab upgrade cost	ASIC/programmable array
Memory	Demand & Cost/bit	New architectures	Wafer fab capability
Military ICs	Commercial actions	Decreasing demand	Technology availability

This results in product life cycles ranging from one to five years for commercial versus ten to twenty-plus years for military. The following table summarizes the product life cycle of typical systems:

Application/Market	Concept/Design	Production	Produced System Life
Personal Computer	6 → 3 months	9 → 3 months	3 to 8 years
Consumer	18 → 6 months	12 → 3 months	3 to 8 years
Automotive	3 → 2 model years	1 model year	7 to 10 years
Defense	3 to 8 years	0 to 20 + years	> 20 years

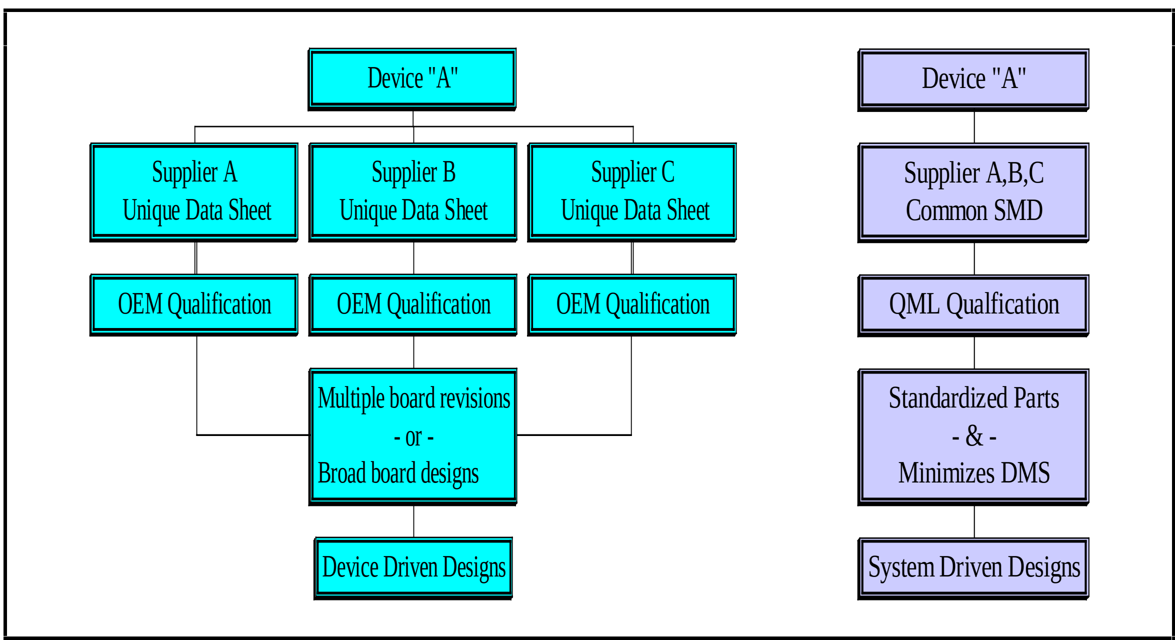
There is a mistaken impression that there are less device obsolescence issues involved with commercial components than with military components. This is far from true. In 1995, approximately 5,000 to 10,000 commercial functions were obsoleted while in military only about 1,400 functions were discontinued. The confusion arises due to functions versus part numbers, package types, speed ratings, and device grades.

Under the QML umbrella, there has been an increase in the number of suppliers and the number of certified processes and manufacturing lines:



There are now over 9748 devices/packages produced from QML lines — 6306 SMD, 2409 JM38510, and 1033 QML device types. Over 284 processes/lines are now approved including wafer fabs and assembly/test facilities both onshore and offshore. Twenty-four companies offer ceramic QML device types and six of these also offer QML plastic devices.

A typical approach to managing obsolescence is to move configuration control from component level to the board level. This results in a significantly more complex procurement system that many OEMs are reluctant to implement:



<u>Component Performance And Qualification</u>

Within the QML infrastructure, an OEM could obtain a device from multiple suppliers to a DSCC defined Standard Microcircuit Drawing and be assured of the performance, quality, and reliability of the product.

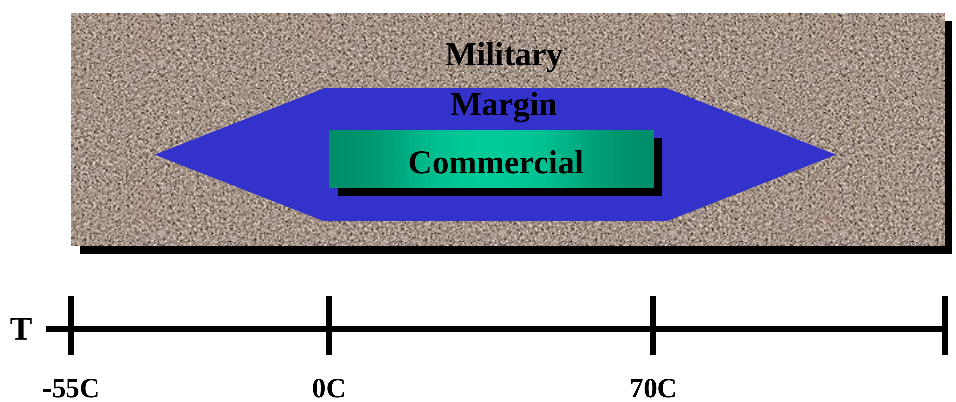
With COTS components, it becomes critical to know and understand the supplier. Unfortunately, since COTS suppliers are driven by the commercial marketplace, the burden of assuring device level performance, quality, and reliability for military applications rests with the OEM. In fact, almost all semiconductor suppliers have disclaimers similar to the one issued by Texas Instruments:

> *Plastic encapsulated Texas Instruments semiconductor devices are not designed and are not warranted to be suitable for use in some military applications and/or military environments. Use of plastic encapsulated Texas Instruments semiconductor devices in military applications and/or military environments in lieu of hermetically sealed ceramic devices, is understood to be fully at the risk of Buyer.*

<u>Electrical Performance Over Temperature</u>

As mentioned earlier, characterization and modeling of COTS devices are typically performed only at the commercial temperature extremes. Due to product liability concerns, most suppliers will not provide electrical characterization test data beyond commercial datasheet limits. Electrical testing is typically performed at only one temperature, usually ambient, and then only on supplier identified key parameters. Performance to the commercial temperature limits, for example 0 °C to +70 °C, is ensured by testing to guardbanded limits. The margin involved over the operating temperature spectrum of a typical device is illustrated below. Lot to lot variability due to normal process variations that do not affect commercial operation can impact military temperature performance and could result in zero yielding lots. This is because wafer fab processes and die designs/re-designs target commercial electrical and reliability requirements. Custom lot selection by the OEM, such as devices from a specific assembly site or wafer fab, is not permitted.

Operating Temperature Spectrum versus Device Margin



For military components, characterization is required for each device or device family at initial release and after die redesigns, die shrinks, or major wafer fab process changes. In some cases performance issues are encountered with operation over the military temperature range (-55 °C to +125 °C), however, in all cases the device will meet the existing or revised commercial (0 °C to +70 °C) or industrial (-40 °C to +85 °C) device specification prior to release. Resolution of these issues by the military test engineer includes:

- Adjusting the wafer fab process
- Continuing to produce the older die revision for military only
- Die banking the older die revision
- Redesigning the die
- Changing the military device specification
- As a last resort, deleting the device from the military device list

Within Texas Instruments, there have been numerous documented cases where COTS devices did not meet the military temperature performance requirements as-is. In all cases the products performed properly to the commercial limits. These devices span several technologies and some examples include:

Device Type	Corrective Action
LM111	Using military unique die
LM118	Military unique die/wafer-fab processes
LM124	Complete die redesign
LM139	Minor circuit redesign
MC1558	Relaxed datasheet
SMJ320C80	Relaxed datasheet
SMJ34082A	Temperature was relaxed
SMJ416400	Reduce 125 °C pause time (64 to 34 ms)
SNJ5404	Military unique die/wafer-fab processes
SNJ5474	Military unique die/wafer-fab processes
SNJ54ALS244	Military unique die/wafer-fab processes
SNJ54AS04	Military unique die/wafer-fab processes
SNJ54F04	Military unique die/wafer-fab processes
SNJ54LS00	Military unique die/wafer-fab processes
SNJ54LS174	Changed wafer fab process
SNJ54S163	Military unique die/wafer-fab processes
SNJ54S32	Military unique die/wafer-fab processes
SNJ55122	Changed datasheet

PEM Reliability Performance

In addition to comprehending variations in electrical performance, the OEM is also faced with ascertaining the intrinsic (life test) and environmental (package related) reliability of a given device type. Unfortunately, this issue is even more complex than the electrical performance issues. A critical consideration then arises with electrical upscreening – just because a given COTS device functions over an extended temperature range in a plastic package does not mean that it will function reliably over that temperature range. Due to differences in package thermal characteristics, a PEM may fail prematurely at temperatures that would not adversely affect the same device in a ceramic package.

Reliability can and does vary from supplier to supplier. It can vary from package to package and from assembly/test site to assembly/test site even from the same supplier. In many cases, reliability varies from device family to device family in the same package outline from same supplier. This is due to constructional differences such as lead frames, package outlines, mold compounds, and assembly processing parameters. For example, some mold compounds are optimized for stress rather than moisture performance. It is critical that the OEM assesses the quality and reliability of each supplier with respect to the target application. The results of the following studies serve to emphasize that point

- Texas Instruments Study (Logic Devices From Six Suppliers)

  Life test -- 0.1 to 66 FITs
  Autoclave -- 0.01 to 4.0% failures
  Temperature Cycle -- 0.04 to 27.0% failures
  Biased Humidity -- 0.01 to 2.0% failures

- University Of Maryland Life Test Data (Devices From Several Suppliers)

Linear ICs	-- 0.6 to 460 FITs
Digital ICs	-- 5.0 to 7.1 FITs
Microprocessors	-- 3.8 to 190 FITs
Memories	-- 2.5 to 50 FITs

- NSWC HAST Data (Logic Devices From Four Suppliers)

DIP	-- 300 to 1,300 hours to 50% failures
SOIC	-- 200 to 400 hours to 50% failures

- John Hopkins University, Applied Physics Lab Navy F/A-18 Program and PEM Long Term Dormant Storage Study August 1996

  - Minor Visual Issues
  - 8 devices failed DPA
  - 17 of 53 devices tested did not meet 25 °C electrical parameters

- CALCE - Degradation due to storage study 1996

  - 274 PEMs tested all passed functional testing
  - Some ceramic devices showed chipping and cracking

- Sonobuoy

  - 78 PEMs tested all passed military temperature testing
  - 19 PEMs decapsulated, no corrosion found

- Wright Laboratory PEM Extended Temp Capability

  - 13 of 686 devices tested did not meet MIL temperature electrical parameters

It should be noted that most studies to-date only address low complexity commodity products. More variability is likely with high complexity products with higher pin counts and with leading edge package designs like very thin small outline packages.

Although industry standards exist for all common PEM environmental tests, this testing does not relate to real world environments. Rather these tests indicate relative performance levels for the specific tests performed. Moisture performance is often affected by handling of devices prior to testing (preconditioning) and may not be indicative of results with standard military manufacturing and depot repair practices. The actual tests performed and test procedures used can vary from manufacturer to manufacturer. Typically data is provided by package family and device family without respect to assembly/test site or wafer fab. Again due to product liability concerns, suppliers will not provide reliability and failure rate models. Quality and reliability data provided is intended to be an estimate of product performance based upon history only. It does not imply that any performance levels reflected in such data can be met if the product is operated outside the conditions expressly stated in the latest published datasheet for a device. Again, reliability testing only provides a relative comparison of "goodness" not suitability.

While military OEMs are accustomed to receiving information on device processing (Processing Conformance Reports) and quality conformance inspection (QCI) with each lot, this information is not provided for COTS devices. Electrical testing details are not listed and not all datasheet parameters are tested. There is no life test information (Group C) or package related information (Groups B and D) provided with the lot. A "Military" Certificate of Conformance is not provided.

Life Test And Comparisons Between Military And Commercial Devices

Data is often cited that would lead one to believe that COTS device reliability is significantly better than that of military components. This is a totally erroneous conclusion caused by a failure to understand the statistical significance of the data. Commercial and military devices are sourced from the same wafer fabs. While in some cases the military devices use a different die revision or different process targets than the commercial die, the intrinsic die reliability is identical. Confusion arises due to the industry standard reporting methods used to specify operating life. Reliability is specified in FITs (Failures In Time). One FIT is equivalent to one device failure in one billion device hours of operation. The number is derived from the total number of device sampled, the number of life test hours, and the number of failures. The failure rate is then derated to +55 °C with a 60% confidence level. Commercial life test monitors consume many orders of magnitude more devices than the military Group C Quality Conformance Inspection testing. Therefore, the published FIT rate is much lower than for the military devices. Again this is sample size driven and does not reflect a true difference between commercial and military grade components.

There is also a tendency to assume that these published failure rates are applicable at the system level. This is not the case in any except the most benign applications. The conditions found during life test, such as constant high temperature, low or no ambient humidity, and continuous device operation, do not address humidity induced failure mechanisms or temperature cycling induced failure mechanisms that are found in non-benign environments. These are addressed by Highly Accelerated Stress Testing (HAST), 85°C/85% biased humidity testing, autoclave, and temperature cycling tests. For moisture sensitive (per JESD A112A) plastic surface mount devices, preconditioning per JESD A113A is performed before the above noted moisture and temperature cycling tests. Therefore, life test data must be supplemented with other environmental test data in determining how a plastic device will function in a given environment. Actual reliability in field conditions is also affected by board assembly techniques and long term storage.

Although some OEMs have proposed establishing a shared device reliability database to facilitate the use of COTS components in military applications, this is far from an ideal solution. The commercial process and device baselines are very dynamic. A "snapshot" of device reliability is not sufficient to ensure that future shipments, or even the next shipment, of COTS devices will meet military systems requirements. Publication of the results of qualification and use of a supplier's devices beyond the supplier's specified limits could result in a civil suit filed by the supplier against the OEM providing the data. By not taking action of this sort, the supplier risks becoming involved in a product liability action involving the OEM ("acquiescence by silence").

Commercial Product Sourcing Practices And Change Control

While military suppliers go to great lengths to ensure that devices perform the same regardless of the wafer fab or assembly test site, the OEM task of maintaining up-to-date qualifications for commercial devices is complicated by the suppliers' internal component sourcing practices:

- Die Level

  - One device can be sourced from multiple wafer fabs
  - Die revision can vary from fab to fab
  - Process baselines vary from fab to fab
  - Burn-in requirements are determined by wafer fab source and die revision
  - Electrical testing can vary as determined by wafer fab source and die revision
  - Some die from some fabs might not function over mil temp or meet mil reliability goals

- Package/Assembly Level

  - One device can be sourced from multiple assembly/test sites
  - Mold compound can vary from site to site
  - Lead frame composition and design can vary from site to site
  - Die attach material can vary from site to site
  - Lead finish can vary from site to site
  - Process baselines vary from site to site
  - Some packages might not perform over extended temperatures or meet mil reliability goals

Notification Of Changes To Form, Fit, Function, And Reliability

Proper maintenance of qualification for a device or device family from a specific supplier requires the OEM to be aware of changes that could affect the performance of the device in their application. With military components, a change in form, fit, function, or reliability is defined by MIL-PRF-38535 and the applicable SMD that comprehends the military environment. With COTS components, form, fit, function, and reliability are defined by the commercial datasheet and the commercial operating environment. In other words, changes are not characterized beyond commercial temperatures. Therefore, only notification of changes in form, fit, and function as defined by commercial datasheet is provided for COTS devices. Customer approval is not required before shipment. Typical practice is to notify directly those customers who have purchased that device type directly from the supplier. Distribution customers are notified by the distributors, although there are currently industry efforts underway to develop a fee-based central notification system via the Internet.

While military suppliers are required to produce homogeneous lots with unique traceability, commercial suppliers are free to define their own lot control systems. Traceability varies from good to none depending on supplier and is typically better looking in (lot traceability) and worse looking out (customer traceability). Commercial lot trace codes, when used, may encompass over 100,000 devices per single code. Commercial record retention is typically one year versus military requirement of five years.

Customer Support Infrastructure

Semiconductor suppliers typically have specific individuals or a separate organization chartered to deal with military customers. This allows supporting the military OEMs as a large “virtual customer” with the same requirements and concerns. Within the commercial operations, however, the organization is primarily structured to support the large direct customers. It is an example of the 90/10 rule – 90% of the resources exist to serve the 10% of the customers that make up 90% of the business. Where the military OEM would benefit from direct support from a dedicated military supplier, with commercial suppliers the OEM would be faced with vying with the other 90% of the customers for 10% of the resources. Application support would most probably be through a distributor.

A significant effect would be in the area of returned device analysis. For example, most OEMs are expected to perform some type of analysis on qualification failures and field failures. In some cases, a contractual obligation exists to investigate multiple component failures during the assembly process before the prime will take delivery of the system. A typical commercial analysis consists of automated test (ATE) sample correlation with failure analysis performed only if judged by the supplier to be warranted, that is, if an intrinsic device defect is suspected as opposed to electrical overstress (EOS) or electrostatic discharge (ESD) damage. Evaluation will only be performed per datasheet specifications, for example, 0 °C to 70 °C. Evaluation cycle time for returns will be extended due to supplier contractual obligations with direct customers and supplier resource constraints. Military OEMs should comprehend typical analysis cycle times of weeks versus days when dealing with commercial suppliers. Most suppliers will not accept a lot for return until sample verification testing is completed.

Some approaches to ensuring the quality and reliability of COTS components advocate the audit and certification of each commercial supplier by the military OEM (Quality System Reviews), similar to the QML virtual customer audits and certification performed by DSCC. These audits of wafer fabs and assembly/test sites by distribution customers are for the most part not supported. When a commercial manufacturer receives a Corrective Action Request for violation of a military or distribution-customer specific requirement, it is most often ignored as each commercial manufacturer defines their own "best practices".

Upscreening Of Commercial Devices

Integrated circuits are designed for use in a wide range of applications. In some cases, the selection of a specific device is not important while in other cases the selection of the proper type of device is critical. Devices are designed and manufactured for various environments ranging from desktop computers to manned space vehicles. Each environment has very different requirements that must be addressed in specifying the devices used in that environment. Upscreening in and of itself voids a manufacturer's warranty and can degrade the overall reliability of devices ("walking wounded") due to handling and EOS/ESD damage. Semiconductor suppliers can not be responsible for the performance of devices beyond the specified data sheet conditions and can not be responsible for any component or system failure due to the misapplication of products. Suppliers typically will not warrant components subjected to up screening. In fact, semiconductor suppliers could be called to testify against upscreening practices should an issue result from the use of their ICs outside of the specified operating temperature range.

Upscreening is usually performed by subjecting COTS devices to a burn-in and then electrical testing over extended temperatures. This is only a viable option for low to medium complexity integrated circuits. For very complex devices such as microprocessors and digital signal processors, a dynamic burn-in is performed with a specific set of burn-in oven vectors for proper exercising of the device. A static burn-in or a pseudo-dynamic burn-in is usually not effective. To perform anything more than a gross functional test at speed, a complex tester is required. The tester would then require a detailed test program and a set of test vectors that exercise the device with acceptable fault coverage, typically over 95%. In addition, reliability testing such as gate oxide integrity testing is performed during electrical testing. The only expertise in performing this level of testing exists at the supplier level. Many thousands of man-hours are involved in developing these programs and test vectors. The burn-in conditions, test programs, and test vectors are considered intellectual property and are not disclosed outside of the supplier. In most cases, even with a non-disclosure agreement the supplier will not release this information due to product liability concerns.

Upscreening Cost Model

Even in the case of low complexity devices, upscreening of COTS devices may not be cost effective. Following is a model prepared to demonstrate worst case costs involved in qualifying and upscreening a typical COTS component.

Model Assumptions

- Assumes 20 pin MSI (medium scale integration) logic surface mount device type
- Assumes 100K units per qualified package type per manufacturer
- Assumes 20K units per tested device type (function)
- Assumes 5K units per test lot
- Screening cost estimates are less component costs
- Environmental screening and test costs are based on 1991 quotes from three environmental test vendors
- Burn-in and electrical test costs are per 1996 quote from one electrical test vendor
- DPA costs are based on 1996 reports from two outside labs

Qualification By Package Type By Supplier

• Autoclave	129 units	$ 250 to $ 750
• HAST (less NRE)	129 units	$ 1,850
• Bias Moisture (less NRE)	129 units	$ 1,500 to $1,800
• Temp Cycle (1000 cycles)	129 units	$ 1,500 to $ 5,250
• Thermal Shock (1000 cycles)	129 units	$ 9,950 to $ 10,000
• Preconditioning		$ 1,500
• Constructional Analysis (DPA)		$ 10,000
• Total	645 units	$ 25,100 to $31,200

100% Screening - 20 PIN MSI Device

• Test programs and test boards NRE	$ 9,500
• Burn-in boards and sockets ($200 X 100 minimum)	$ 2,000
• Temperature Cycle (100 cycles)	$ 1,500 per lot
• Burn-in and electrical test (pre, post 3 temp)	$ 2.50 per unit

Amortized Upscreening Costs

• Package qualification cost per unit	
- HAST/Bias Moisture NRE (4 boards at $1K each)	$ 0.040
- Environmental testing	$ 0.251 to 0.312
• 100% screening cost per unit	
- Test and burn-in NRE	$ 0.575
- Temp Cycle	$ 0.151 to 0.212
- Burn-in and electrical test	$ 2.500
- Yield loss at 10% (will vary by lot)	$ 0.320
• Total Cost per unit less component cost	$ 3.546 to 3.607

Amortized Upscreening Costs Summary

- Total upscreening cost per unit less component cost $ 3.58 average
- Typical distribution device costs

- Commercial Plastic Device	$ 0.25
- Upscreened Commercial Plastic Device	$ 3.83
- QML Ceramic Device	$ 1.50

As shown above, the costs of upscreening a commercial plastic part fully to approximate the same levels as QML ceramic can exceed the cost of purchasing the QML ceramic device.

QML – The Best of Both Worlds

The "Perry Directive" was a decisive action aimed at moving the defense procurement process away from the strict, regimented "mil-spec" system that, in many cases, added unnecessary costs to defense contracts. At the same time, the Department Of Defense (DOD) sought to implement "Best Commercial Practices" and to use many of the advantages found in the commercial world. Although the military semiconductor industry did not foresee the DOD's action, its members recognized early the need for changes in military ICs manufacturing and procurement. More importantly, they recognized that their customers' needs were changing. As a result, key industry members began working proactively in the mid-1980s to develop a methodology that preserved the high-quality, high-reliability ICs the armed services had come to expect while also incorporating the most advanced commercial qualification and procurement methods. The result was a comprehensive process methodology named the Qualified Manufacturer's List (QML).

The DOD originally listed the Qualified Manufacturer's List as an ordinary military standard. It was a mil-spec for classification purposes, but for practical purposes, it was anything but a mil-spec. The government formally recognized this in early 1995 and gave QML the status of MIL-PRF-38535. This means that QML officially went beyond mil-spec status to meet the definition of a "performance based specification" as called for in Dr. Perry's earlier mandate. For both IC manufacturers and defense contractors, the decision went a long way in providing an IC standard that offers the best of both the military and commercial worlds.

To military OEMs, the prospect of ensuring the quality of multiple suppliers seems to be an almost impossible task. QML is designed to incorporate best commercial practices into its comprehensive methodology. The QML process is flexible and allows the semiconductor manufacturer to do the thing he does best – continuously improve the process for manufacturing a quality product.

For the manufacturer, and ultimately the consumer, the most important benefit of QML is it allows the elimination of non-value-added steps. The older QPL specification mandated each and every device from an IC assembly line be subjected to the same rigorous quality checks, despite years of data indicating parts of the screening process were unnecessary. The QML process allows the advantage of analyzing data gathered from the manufacturing and testing process. When the manufacturer has sufficient data to prove a particular step is no longer necessary, he can delete it.

Another advantage of QML is it qualifies the entire product family via certification of the process flow. Once an IC company's process has been certified or listed as QML, the manufacturer must continually meet or improve upon the established baseline under which it qualified.

From a production perspective, QML customer benefits include the manufacturer's ability to convert rapidly to new technologies. Reduced screening means reduced cycle times. Since QML allows elimination of non-value-added manufacturing steps it has the potential for cost containment. In addition to rapid product introduction, reduced cycle time and potential cost savings, QML devices do not suffer from the defects sometimes induced by an extensive screening process. Rigorous screening does not improve the quality of the part. In some cases, it may even hinder device quality.

While, QML incorporates many of the benefits found in the commercial IC manufacture, qualification and procurement world, it also retains the best features traditionally found in the military IC world. Retained are the types of special services military customers have come to expect as vital to the specialized design and procurement environment in which they work. Configuration control, device traceability, standardized supplier certification and obsolescence controls are just some of the benefits of QML. In addition, early in the life of the QML program, DSCC recognized that QML certification resulted not only in higher quality products but in improved quality organizations as well. Therefore, DSCC considers QML product equal to or better than QPL products. Jim Blanton of DSCC explained, "The QML approach is basically a validation that a company is well managed and technically sound enough to be "World Class" with minimum government interference."

The optimum solution for a military OEM desiring the lowest cost of ownership combined with a broad selection of products is the QML system.

Summary Of Differences Between Commercial And Military Components

As noted above there are significant differences in the product offering between commercial and military suppliers just as there are differences in the support infrastructure. The following table lists some of the essential needs and concerns of the military OEM and summarizes differences between the commercial and military component families:

	Commercial Plastic	**QML Plastic**	**QML Ceramic**
Initial Price	Lowest	Mid-range	Highest
Temperature Range	0 to 70 °C	-55 to 125 °C	-55 to 125 °C
Electrical Test	Datasheet	SMD	SMD
Lead Finish	Palladium, copper	Palladium	Hot solder dip
Long Term Reliability	Good	Good	Best
Supplier Responsiveness	Dependent on revenue	High	High
Storage And Processing	Additional requirements	Additional requirements	As current
Availability	Prevailing Market	Good	Good
Product Spectrum	Best	Weak but improving	Good
Time To Market	Best	Good	Good
Obsolescence Control	Minimal	Better	Best
Traceability	Minimal to good	Best	Best
OEM Special Requirements	Not available	Not available	Available
Change Notification	Limited	GIDEP	GIDEP
Supplier certification	By user	DSCC	DSCC
Supplier Selection	Critical	Less important	Less important

Conclusions And Recommendations

In conclusion, the key points to consider are:

- The use of PEMs may be acceptable in some military applications, however, long-term reliability in harsh conditions is not fully understood and such use must be at the sole risk and responsibility of the OEM.
- Obsolescence issues are worse with COTS components.
- There will not be the same level of supplier support for military OEMs switching to COTS components.
- When using QML devices, the OEM usually only has to be concerned with the application ("from the pins out") – with COTS devices, the OEM also has to be concerned with device itself ("from the pins in").
- Upscreened COTS devices can exceed acquisition costs of ceramic QML devices due to screening costs and yield losses.
- Upscreening can degrade component reliability and can void the manufacturer's warranty. Without detailed knowledge of the device design, the use of upscreened components can result in field failures.
- Reliability testing only provides a relative comparison of "goodness" not suitability for use in a specific application.

To the military OEM industry market segment, our recommendations are to:

- Forget about influencing commercial suppliers
- Determine your real needs
- Proactively work with IC manufacturers
- Use QML parts as first choice
- Reward those suppliers that meet your total needs
- Do not use PEMs beyond the manufacturer's specifications
- Forget initial cost – think total cost of ownership for system life