OPTION 4 OF MIL-H-38534: A QUALITY MANAGEMENT SYSTEM FOR BUILDING COMPLIANT HYBRID MICROCIRCUITS FOR MILITARY USE

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ABSTRACT

This paper describes the proposed Option 4 which will be included in the next amendment of MIL-H-38534, General Specification for Hybrid Microcircuits. This paper will explain the philosophy and the methods used by this new option which include the use of Design Analysis, Design of Experiments (DOE), and Statistical Process Control (SPC). With this option, these methods may be used by the manufacturer's Technology Review Board (TRB), a group of representatives from each major function within the hybrid area, to eliminate or modify inspections and tests within the manufacturer's Quality Conformance Inspection (QCI) and screening tests which are performed to a baselined Option 1, 2, or 3 flow. These methods may also be used to modify the design and construction requirements contained in MIL-H-38534. The process of eliminating or modifying any inspections, tests, or requirements will be handled by the TRB and be monitored by the qualifying activity. When the TRB decides to modify the requirements or tests they must have data to explain how they came to that conclusion and must show that this decision is valid. The TRB must also periodically access the alternative method being used and insure that the prior decisions of the TRB are still valid. Furthermore, this paper will explain why a manufacturer would want to implement this option and what benefits the customer will get. The manufacturer would want to get involved so that they can eliminate tests that, for their particular process and conditions, are not value-added processes. These eliminations and modifications should be seen by the customer as reduced prices for compliant hybrids, a quicker turn-around time for compliant new technology hybrids, and increased quality due to decreased handling.

The military electronics market is changing rapidly in these times of relative peace. With the military controlling a smaller and smaller share of the total market for high reliability microelectronic devices, it is increasingly more difficult for the logistics community to dictate to the supplier's how to do business. In light of this fact, the Department of Defense (DOD) is looking for new and innovative ways of procuring the much needed high reliability microelectronic devices. This proposal is one way that this is going to be done. It is a plan which will allow the manufacturers of military hybrid microcircuits and Multichip Modules (MCMs) to manufacture their military devices in a manner that makes sense for their particular processes and applications.

The proposed option is called Option 4 and consists of innovative ways of evaluating a manufacturer and ways that that manufacturer may control his product without necessarily performing all of the currently required tests and inspections. This proposal relies heavily on the use of alternative methods of controlling and evaluating products. Currently, a compliant manufacturer must perform a series of rigorous tests and Screens, on every device to weed out all defective products. From the passed devices a sample is taken which is then subjected to another series of tests and inspections, Quality Conformance Inspections (QCI). As long as a statistically sound number of the samples pass the inspections, the lot is approved and shipped. These tests and inspections are extremely costly and that cost is passed on to the customer, the DOD. Some of these tests may be unnecessary if the manufacturer has, and can prove he has, control over the process that is being investigated by the inspection in question. This is the basic premise behind Option 4. If the manufacturer is capable of deleting a test or inspection then the part is handled.
less, which lessens the likelihood of damage, and is less costly to produce. This should result in better products being produced at a lower price to the DOD.

Obviously, the main question is how will a manufacturer control the processes necessary to the satisfaction of his customer and the DOD. This will be accomplished through the use of a validation, a Quality Management (QM) plan, various alternative methods, a Technology Review Board (TRB), a status report, and a Customer Compliance Matrix (CCM).

Rather than using an audit procedure a validation will be performed by the Qualifying Activity (QA). In this procedure the QA will visit the facility and review the manufacturers QM plan and TRB. Basically, the QA will look at how the manufacturer wants to implement or is implementing the requirements and then decide whether their implementation is actually meeting the requirements. If the QA believes, based on the QA's knowledge and experience, that the manufacturer's plans are suitable than the manufacturer may continue with his Option 4 plan as outlined in his QM plan.

The QM plan is the way in which the Option 4 program will be implemented by the manufacturer. This plan will outline all aspects of the companies approach to building devices using the Option 4 approach. The QM plan will include organizational charts and charters, flow charts, TRB charter and procedure, procedures for alternative methods, and numerous other documents which describe the way the manufacture will produce and evaluate their products. This plan will replace the currently required Quality Assurance Program Plan which is used for options 1, 2, and 3. The QM plan lays the ground work for the remaining aspects of Option 4.

Alternative methods is the approach taken to delete, substitute, or modify a design, construction, or test requirement. This modifying of the baseline requirements may be done for a number of reasons, including but not limited to data gathered through the use of DOE, SPC, periodic assessments and certification, etc.. Though a manufacturer may have deleted or modified a test or inspection, the products built must still be capable of passing the baselined Option 1, 2, or 3 test or inspection. The data or proposal of an alternative method must be evaluated and approved by the TRB for the modification to be used.

The TRB is perhaps the most important aspect of this option. The TRB is a group of representatives from all major functions involved in the manufacture of the hybrids. This group will develop and maintain the QM plan and all supporting documents. They will also oversee all certification and qualification activities. Possibly their most important role will be as the final decision makers for all alternative methods. The decisions made by the TRB must have corroborating data and must be reported to the QA through the use of a status report.

The status report is the vehicle used by the manufacturer to inform the Qualifying Activity (QA) of the actions taken by the manufacturer to improve quality and lower cost. This report will include minutes of the TRB meetings, data concerning shipped devices and any failures encountered, any changes made to the design, manufacturing, or testing of the devices, and any change in the qualified processes. The QA will use this report to ensure that the TRB is making intelligent decisions and that there is data to support the decisions. This is the format used by the QA, and subsequently the DOD, to ensure that the compliant hybrids being produced are always of the highest reliability available.

In addition to the DOD needing to know what the manufacturer is doing, the manufacturer's customers need to know also. This is accomplished through the use of a Customer Compliance Matrix (CCM). This document will describe the requirements of the customer and how these requirements are being met by the manufacturer. The CCM will document the correlation between the alternative methods being used and the baselined Option 1, 2, or 3 methods. Though the devices built under the modified requirements are still required to meet the baselined requirements, the customer should thoroughly evaluate and understand this matrix and ensure that the alternative methods used will not jeopardize the end product in any way.

A manufacturer building a compliant device to the present requirements would need to perform a Gross and a Fine leak test as a part of screening and QCI. This test is performed to insure the hermeticity of the hybrid package. As an example of how a test may be deleted using Option 4, these tests during screening will be considered. The manufacturer may have data showing that they have not experienced a leak failure in many years, therefore these tests would be a candidate for elimination. Then the manufacturer uses DOE to determine the best settings on the sealing machine, and ensures that these settings are consistently used. Furthermore, the manufacturer tests a certain number of devices immediately
following the sealing process to "certify" the setup of the machine and documents this process and the settings resulting from the DOE analyses. The TRB may decide that the leak tests performed during screening are no longer applicable based on the data and the added machine setup certification. The next status report would need to make note of this modification as would the CCM. Now the manufacturer may continue making compliant hybrids without performing one of the screening tests, thus saving money and lessening the handling of the completed hybrid.

The proposed Option 4 will alleviate many of the problems facing the military hybrid microcircuit industry today. When implemented properly all parties involved will reap the rewards of lower cost, higher quality and reliability, and shorter development time for compliant devices while improving the standardization effort.

With the reduction and/or modification of some of the requirements, the manufacturer will not need to handle the parts as much as is currently necessary. This reduction in the handling will have a direct effect on the number of failures encountered due to electrostatic discharge (ESD) and other handling related effects. The manufacturer will not need to perform as much rework since the failures have been reduced. The customer will receive a higher quality part and be able to have more confidence in the part, and the government will receive systems with less field failures.

As the requirements are modified or deleted, the cost to produce the parts will decrease. The manufacturer will be able to lower his price and therefore increase his market share. The customer and the DOD will use this system due to the higher quality parts and reduced cost.

One of the most prevalent problems with the present system is the fact that the requirements do not always address new technologies. Presently many manufacturers would like to use Tape Automated Bonding (TAB) devices, Fiber-optic devices, stacked die technology, and so on. The present requirements do not easily lend themselves to these and other new technologies. The industry is changing at such a high rate that it is impossible for the specification to be constantly up to date. With this proposal in place a manufacturer's TRB may decide what requirements apply to their technology and what extra requirements will be necessary to produce high quality products. This application of Option 4 will allow a manufacturer to offer compliant hybrids much earlier in the development cycle of the technology then is possible today. This allowance will keep the customers on schedule and aid the DOD in standardizing these new technologies. It will improve the DOD's standardization effort by allowing more qualified devices to be built and be documented within the framework of the Standardized Military Drawing (SMD) program.

The manufacturer of the hybrids will certainly want to pursue this option for the freedom and control it offers them while still producing a high quality product at reduced cost. The reduced cost and improved quality along with the control offered by the CCM will encourage the OEM to buy the Option 4 devices. The cost and quality along with the improved standardization and the control given by the status report and the initial validation will spur the DOD ahead with this plan. Obviously, all players should be intensely interested in this program.

This proposal has some very appealing ideas. With the control offered by the CCM and the status report the use of the option should be well regulated while giving the manufacturer the leniency needed to produce quality devices at a reasonable cost and keep the systems on schedule.

At this time Option 4 is just a proposal. Though it is a proposal that is currently receiving much attention it is unsure at this time how much the proposal may change before it is included as an appendix to MIL-H-38534. This option should be included in the next amendment to MIL-H-38534.