

University of Arkansas Microelectronics-Photonics Graduate Program

PhD Candidacy Exam – March 2004

Materials and Processing Area of Emphasis Exam

PROBLEM TO BE SOLVED

A growing number of microelectronic systems are being developed that, for reasons of either national security or corporate propriety, require that details of their specific architecture, layout and components be kept secret beyond their companies of origin. Your company has a government contract to produce an electronic system consisting of a radio transceiver and associated digital signal processing equipment in a single secure enclosure. The prototype system so far has these characteristics:

- FR4 circuit board, 12 layers, utilizing 1/2 oz Cu interconnects
- board dimensions: 8 x 4 cm, 96 mils thick
- 8 surface mount IC's (these can be packaged any way you want)
- 42 surface mount passive components
- connector for 5 V power
- connectors for signal in and signal out
- total mass for the prototype board, connectors, chips etc: 180 grams

Your job, as chief engineer of this company, is to design an enclosure for this system that, if the system falls into the wrong hands, will make it impossible for anyone to determine the nature, type, connection and functionality of the components inside, as described above. You should prevent them from learning anything about the electrical system, whether they use intrusive or non-intrusive means.

You may use techniques that are destructive to a limited number of internal components but not to the entire system if you wish, and these means are allowed to create fumes that might be hazardous to the person attempting to gain access to the system. But remember, the goal is to guard the information contained in the system, not to act as a physical threat to the intruder because that won't stop the next person from following the first. Any answer that includes explosive destruction of the entire system will be marked as failed.

The maximum allowable size for this enclosure is 400 cm³ and 900 grams total mass.

You must address all pertinent aspects of the materials and processing of this device. This should include materials of construction, how they are assembled, their reaction to their environment, etc.

YOUR DELIVERABLE

Your task is to write an internal proposal for your corporate officers describing your solution to this problem. Be sure you address all of the following:

Current State-of-the-Art - What is already being done in this area by other researchers, companies and governmental institutions? The current state-of-the-art for both the science and the implementation should be described, making use of diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. Be sure to cite all references used.

Your Proposed Solution - Describe in detail your solution to this problem, including both the scientific/engineering basis and method of applying this to a workable solution.

Manufacturing Flow - Detail the step-by-step procedure for making this product.

Testing and Qualification - Describe a set of tests and demonstrations that you will use to demonstrate the effectiveness of your approach. These should include tests that show that the device can work as intended with your protection scheme in place.

Cost Analysis - Perform a cost analysis that includes, at least, acquisition of raw materials, labor rates, costs per operation, testing and qualification etc. assuming quantities of 10,000 parts per year. You may exclude from your analysis possible additional costs in such infrastructure areas as human resources, facilities engineering, janitorial and grounds, upper level management, etc. You must include all direct manufacturing costs, both startup and continuing; and you must discuss explicitly space and personnel requirements to set up a stand-alone product line. Generic per process costs for various manufacturing methods can be used, as long as they are rationally applied.

Intellectual Property - List all IP sources that were consulted while formulating the answer, and include the full list of examined documents as an appendix to this exam. (The full list will not be counted as part of the 15-page limit.) From this list, identify the three that are the most significant threats to the IP you have created in your solution.