

ENGINEERING PRACTICES STUDY

TITLE: SURVEY TO ESTABLISH LASER MARKING REQUIREMENTS  
FOR MIL-PRF-19500  
Comment review

2 January 2013

Study Conducted by DLA LAND AND MARITIME

Prepared by:

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I. OBJECTIVES: DLA Land and Maritime-VAC conducted a survey on Laser Marking Requirements for Semiconductor packages of MIL-PRF-19500. The purpose of the survey was to obtain input from the military services, manufacturers, and user communities concerning laser marking requirements on semiconductor packages.

II. BACKGROUND: The MIL-PRF-19500 currently does not provide any guidance for the laser marking of semiconductor packages.

Currently some semiconductor packaging companies are using laser marking and some are planning to start laser marking on packages because of its excellent durability, output rate and reduction of counterfeit concerns. However, there have been some issues raised when performing laser marking on semiconductor packages such as the laser beam damaging material layers, cracking the seal, damaging the die surface due to local heating and radiation of laser beam.

DLA Land and Maritime - VAC has distributed the following survey questions and laser marking requirement proposals in **Attachment 1**.

III. RESULTS: The initial comments received by DLA Land and Maritime have been reviewed and a summary is listed in **Attachment 2**. All further comments on this study shall be submitted to [jason.hochstetler@dla.mil](mailto:jason.hochstetler@dla.mil). Resulting coordinated changes will provide a basis for updating MIL-PRF-19500 with laser marking requirements. Comments to this study shall be submitted to DLA Land and Maritime within 45 days from the date of this letter.

IV. CONCLUSIONS: Based on the comments received, there have been reported problems with laser marking creating pin holes in packages. New requirements are needed to ensure proper marking is performed, but not all laser markers used today need the proposed requirements listed in **Attachment 1**. A detailed qualification report should show these requirements are not needed when using a dot matrix type laser mark, or a laser with an adapted wavelength based on the surface material.

It was proposed to add the following tests for laser marking to TABLE E-III, of MIL-PRF-19500, Testing guidelines for changes to a qualified product. Salt Atmosphere (C4 TM1041), Moisture (TM1021), External visual (TM2071), and Leak rate (TM1071).

Laser marking will almost always penetrate the typical plating thickness exposing the Kovar, Ni, or base metal. -Should there be an exemption of the minimum plating thickness if laser marking is used? (Would this exemption apply to all package materials?) Or should MIL-PRF-19500 still require the historical minimum amount of plating under the laser marking?

The final comments on this study will be published in a final EP study report after all submitted comments have been resolved.

V. RECOMMENDATIONS: DLA Land and Maritime recommends that the proposed additions to the laser marking requirements be added to the next revision of MIL-PRF-19500. In addition, an evaluation of the existing plating thickness requirement should be done to ensure the proper thickness is maintained after laser marking or an exemption should be added for laser marked devices. DLA Land and Maritime recommends that all military and industry representatives review the proposed changes for laser marking and provide comments.

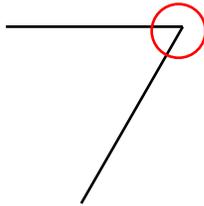
**Attachment 1**

**Survey Questions:**

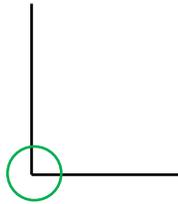
- 1) Is your company performing laser marking on any of the following packages: plastic, metal, ceramic or glass? (if YES please provide your experience, comments and technique used for each)
- 2) Do you agree laser marking requirements need to be included in MIL-PRF-19500? (currently MIL-PRF-19500 allows ink and laser marking but there are no requirements and user guideline/test methodology on laser marking) Suggested requirements are shown below:
- 3) Is your organization using laser marked parts and if so, have you had any issues with laser marked parts?
- 4) General comments/suggestions for laser marking requirements in MIL-PRF-19500.

**Suggested Laser Marking Requirements:**

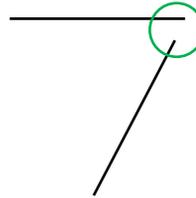
1. A maximum allowable depth (to be determined), while still meeting the plating thickness of table H-I of MIL-PRF-19500.
2. No double marking.
3. No continuous font line that requires a turning angle  $< 90$ , these shall have a break in the font line.



Reject

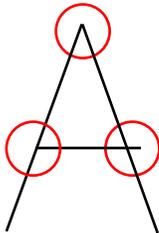


Accept

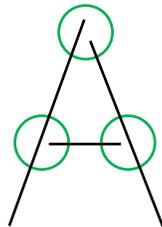


Accept

4. No crossing lines or connection between lines.



Reject



Accept

## **Attachment 2 Summary of survey question responses:**

1) Is your company performing laser marking on any of the following packages: plastic, metal, ceramic or glass? (if YES please provide your experience, comments and technique used for each)

-Yes (Ceramic, Metal)

2) Do you agree laser marking requirements need to be included in MIL-PRF-19500? (Currently MIL-PRF-19500 allows ink and laser marking but there are no requirements and user guideline/test methodology on laser marking) Suggested requirements are shown below:

-It was agreed that laser marking requirements were needed but the initial proposals listed in the EP study reflected old technology and are not relevant to the newer dot matrix style laser markers. The other suggestions that were submitted were more applicable for the initial qualification of the laser marker that would be normally covered under getting new equipment qualified (have a study of laser power vs material (base material, plating layer, etc) vs depth). It was suggested to use this data as their process document to control the laser settings. In addition it was suggested that if a continuous type of laser was used in lieu of a dot matrix style then they should show there is no burn through during overlap and near laser passes. Some packages are not suitable for laser marking (packages containing external BeO for example, but also others that don't provide certain space or for constraints of surface properties). Ink marking provisions must therefore be kept.

3) Is your organization using laser marked parts and if so, have you had any issues with laser marked parts?

-Problems that were reported included pin holes created by the laser marker passing over an area on characters that have corners or crossing over a previously marked area.

4) General comments/suggestions for laser marking requirements in MIL-PRF-19500.

-Add the following tests for laser marking to TABLE E-III, of MIL-PRF-19500, Testing guidelines for changes to a qualified product. Salt Atmosphere (C4 TM1041), Moisture (TM1021), External visual (TM2071), and Leak rate (TM1071).

-Laser marking is not providing any provision or solution to counterfeiting. Machines for laser marking are readily available everywhere and can be set up within minutes to reproduce any marking, incl. choice of fonts, spacings, etc.

-Since MIL-PRF-19500 allows laser marking liberally and it is currently in practice among many suppliers, a suggestion was made to require suppliers to document their set-up conditions relative to the material they apply the laser marking. In general, when supplier's set-up their equipment the normal qualification is to just visual inspection and hermetic seal testing to ensure that their set-up did not caused any pin hole. This methodology is not sufficient, we need to understand and see data if the set-up is truly effective by looking at the depth (by cross-sectioning or micro-sectioning) of the laser etch vs power setting vs the materials where the laser marking is applied. Differences in material will have varying degree of laser burns or penetration, some like shiny material will deflect some of the energy thereby you have to adjust power to compensate, some darker or matt finishes can absorb more energy thereby burning more faster.

-Laser marking always does penetrate the plating in case plating is present (as for all surface mount packages). The standard plating thicknesses are in the order of 50-300 microinches. Laser marking typically penetrates at least a couple of mil. The base metal Kovar is sufficiently inert, similar to the Ni as the standard cap material.

-One of the most important items is the wavelength of the laser. One of the companies has chosen a dedicated wavelength laser, in order to get free from a risk of deep attack of its very thin layer. This kind of laser allows them to performing some hatching (very useful for logos branding...), and allows several passes in the same place without any risk of creating a deep groove. In this case a detailed qualification report clearly explains why this company does not agree with the suggested laser marking requirements, which talk about forbidding continuous lines with a turning angle <90°, crossing lines or connection between lines. With an adapted wavelength, this kind of lines configuration is possible. There is agreement with these requirements if the laser wavelength is not adapted with the surface. More up-to-date laser marking system work on a dot matrix basis, which ensures that there is no double marking.