PRINTED CIRCUIT LINE HEIGHT MEASURING TECHNIQUES

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A device is designed whereby the height of printed circuit lines can be measured using a light-sectioning method. The device projects images, which are visually perceived by an operator via an existing microscope, but can be adapted for video imaging usage as well as for checking the component mounting height.

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The objective lens 11 (Fig. 1) focuses the reticle 12 pattern onto target surface 15. The microscope superimposes target image 15 with pattern 13 on reticle 14 whereby an operator can make a comparison to determine z displacement.

Two parallel light sections are projected to be used in reference with each other for threshold measurements, thus improving the speed and ease of measurement. The device is also equipped with a rotatable reticle holder (Fig. 2) which allows planar images to be focused onto the target surface 15. Lines on the circuit board, lying in the x, y plane, are generally aligned along either the x or the y axis so the device consists of two light section projectors mounted 90 degrees from each other about the z axis. Both projectors have an incident angle $\theta_1$. 

FIG. 2
to the circuit board surface of 45 degrees. The microscope axis is perpendicular to the target surface, causing the lateral displacement to equal the height of a particular topology.

The double light section method makes use of the relationship between two parallel light sections (Fig. 3). The projector is rigidly mounted to a microscope frame of reference and calibrated to focus in the same plane as the microscope. Variations between operator eyesight can be adjusted by eyepiece positions or by the addition of a rack and pinion z adjustment to the light section mechanics, to perform an equivalent function as moving the eyepieces.

To make a measurement the operator moves the target under the light section and focuses the light section image onto the target. The operator then checks to see how the segment of line 1 which reflects off the line, is referenced to the segment of line 2 which reflects off the laminate (Fig. 3A). If these segments line up (Fig. 3B), then the height at that location is equal to the spacing between the centers of the light sections. If the segments are not aligned, then the height is less than or greater than the spacing between the centers, depending on the direction of the light section spacing.

A single light section can be reduced to an ideal line by taking
the centered pixels and averaging them (Fig. 4). Accomplishing this with accuracy requires the consideration of the first derivative 16. Using the location of the derivatives to determine the beginning and ending points of flat surfaces, the average of the pixel y values between their points to give a straight line.

For automated inspection of light sections and to feed in data at cost effective rates, multislit images are fed into a 2-dimensional array or 2-dimensional light sensor, thereby lengthening the light section. This brings about a consideration of effective length which increases exponentially with increases in maximum length. Effective length is the sum of all the light section lengths within a field of view and it allows an error caused by slightly uneven height of the surface to be distributed across the field of view.