Microsectioning:
A Compensation Formula
By Richard E. Olsen

Measuring copper thickness in plated through-holes is a basic quality function in the PCB industry. Every customer specifies a thickness for hole wall copper.

The best technique for measuring copper thickness in a hole is to microscopically evaluate a cross-section. However, the cross-section must be ground exactly halfway through the hole if accurate thickness measurement is to be achieved. If the sample does not extend halfway through the hole, the copper will appear thicker than it actually is. For large pin- and mount-type holes, the thickness measurement error is negligible even if the section is several roils away from the center line. For smaller holes, the error is magnified and must be corrected early on.

Formulas exist for determining actual copper thickness by examining a section not ground to one-half the distance of the hole. Three measurements are needed to determine actual hole wall copper thickness. These three input values (Figure 1) can be used to determine two output values (all dimensions are in roils). The three measurements are as follows:

- **D1** = Diameter of drill used.
- **D2** = The apparent drilled hole diameter as read on the microscope. (This will be less than or equal to D1.)
- **T1** = The apparent hole wall copper thickness as read on the

Figure 1. Measurements for determining actual hole wall copper thickness.

Figure 2. Critical hole dimensions.
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Figure 3. Equations for determining the value of \(T\) and \(H\).

\[
H = \sqrt{\left(\frac{D1}{2}\right)^2 - \left(\frac{D2}{2}\right)^2} = \frac{1}{2} \sqrt{D1^2 - D2^2}
\]

\[
R = \sqrt{H^2 + \left(\frac{D2}{2} - T\right)^2} = \sqrt{\frac{D1^2 - D2^2}{4} + \left(\frac{D2}{2} - T\right)^2}
\]

\[
T = \frac{D1}{2} - R = \frac{D1}{2} - \sqrt{\frac{D1^2 - D2^2}{4} + \left(\frac{D2}{2} - T\right)^2}
\]

Figure 4. BASIC program for determining actual hole wall copper thickness.

```basic
10 REM
20 REM HOLEWALL.BAS
30 REM by Richard Olsen
40 REM (c) 1988 Continental Circuits Corp.
50 REM
60 PRINT "True hole wall thickness program."
70 PRINT "Type in drill hole diameter in mils."
80 PRINT "(Press enter with no entry to quit.)"
90 INPUT D1$ : IF D1$="" THEN CLS : END
100 D1 = VAL (D1$)
110 PRINT "Type in the apparent drill hole diameter."
120 INPUT D2
130 PRINT "Type in the apparent hole wall copper thickness."
140 INPUT T1
150 PRINT "The coupon is 'H' mils off center."
160 PRINT "The actual hole wall copper thickness is 'T' mils."
170 PRINT "The actual thickness is T. The distance between the cross-sectional plane and the center plane is H (Figure 2). It cannot be determined using these formulas if the section extends beyond or does not reach the center. This can be determined only by observing the cross-section at an oblique angle. The equations for deriving \(H\) and \(T\) are illustrated in Figure 3.

These formulas were compiled in the standard BASIC program reproduced in Figure 4. Type the program into a file called HOLEWALL.BAS. Then run the program for BASIC. You will need three input values, as seen in Figure 1.

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