Microsectioning: A Compensation Formula

By Richard E. Olsen

A tool for ensuring accurate hole wall copper thickness.

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

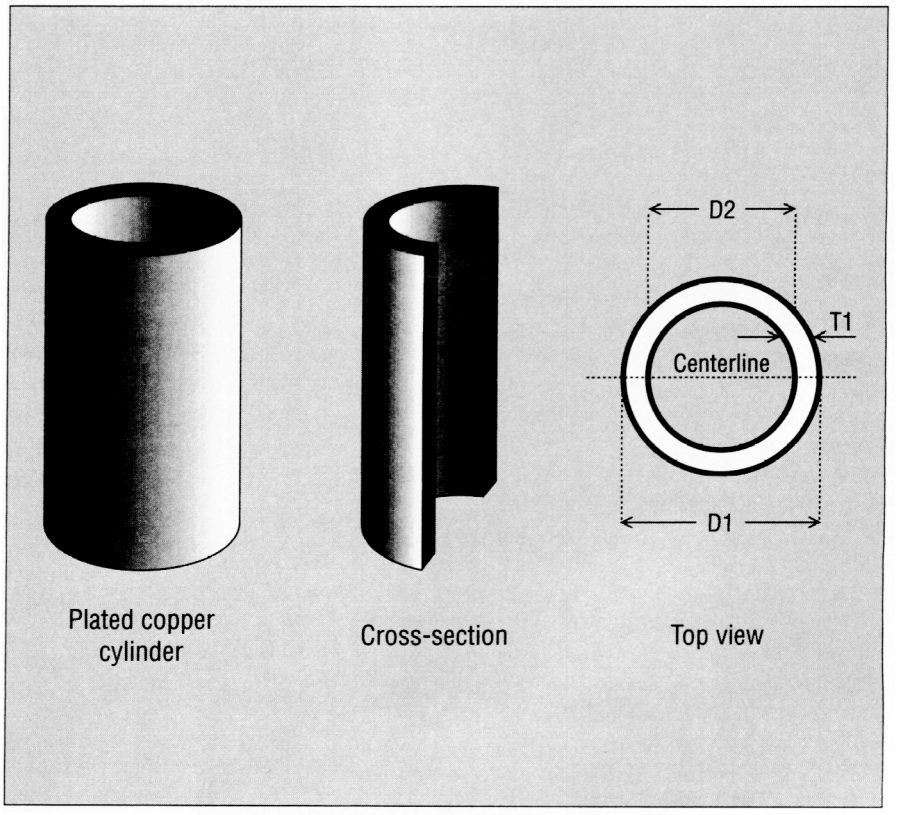

Figure 1. *Measurements for determining actual hole wall copper thickness.*

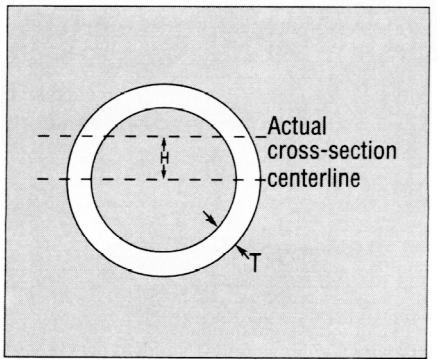

Figure 2. *Critical hole dimensions.*

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

$$R = \sqrt{H^2 + \left(\frac{D2}{2} - T1\right)^2} \qquad = \sqrt{\frac{D1^2 - D2^2}{4} + \left(\frac{D2}{2} - T1\right)^2}$$

$$T = \frac{D1}{2} - R \qquad = \frac{D1}{2} - \sqrt{\frac{D1^2 - D2^2}{4} + \left(\frac{D2}{2} - T1\right)^2}$$

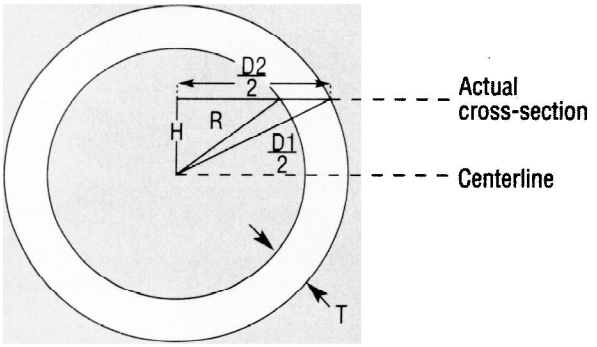

Figure 3. *Equations for determining the value of* T *and* H.

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

```
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 diamter in mils."
80  PRINT "(Press enter with no entry to quit. )"
90  INPUT D1$     : IF D1$="" THEN CLS : END
100 DI=VAL (D1$)
110 PRINT
120 PRINT "Type in the apparent drill hole diameter. "
130 INPUT D2
140 PRINT
150 PRINT"Type in the apparent hole wall copper thickness. "
160 INPUT T1
170 PRINT
180 H=1/2*SQR(D1^2-D2^2)
190 T=D1/2-SQR((D1^2-D2^2)/4+(D2/2-T1)^2)
200 PRINT "-------------------------------------------------------------"
210 PRINT  "The coupon is 'H' mils off center. "
220 PRINT "The actual hole wall copper thickness is 'T' mils."
230 PRINT "'-------------------------------------------------------------'
240 PRINT: PRINT : PRINT
250 GOTO 60
```

If the sample does not extend halfway through the hole, the copper will appear thicker than it actually is.

microscope, (This measurement will be greater than or equal to the true thickness.)

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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