New Thick Film Feedthrough Configurations

Kansas City Division

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NEW THICK FILM FEEDTHROUGH CONFIGURATIONS

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Final Report
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Abstract

An investigation determined that thick film feedthroughs could successfully be printed with 12-mil holes in 20-mil square pads, 10-mil holes in 15-mil square pads, 6 x 12-mil oval-shaped holes in 10 x 35-mil rectangular pads, and 6 x 9-mil oval-shaped holes in 10 x 25-mil rectangular pads. The results were verified by printing test vehicles containing the four feedthrough configurations, electrically testing the feedthroughs for continuity, and cross-sectioning each of the feedthroughs in two axes.

Summary

An investigation was performed to determine if thick film feedthroughs could be printed utilizing smaller hole sizes than previously used. The goal was to develop a thick film feedthrough small enough to fit within a typical thick film conductor line 10 mils wide.

A thick film feedthrough test vehicle was designed and fabricated that incorporated four feedthrough configurations. The feedthroughs were made using 12-mil holes in 20-mil square pads, 10-mil holes in 15-mil square pads, 6 x 12-mil oval shaped holes in 10 x 35-mil rectangular pads, and 6 x 9-mil oval shaped holes in 10 x 25-mil rectangular pads.

The test vehicles were printed on 40-mil thick ceramic using gold conductor paste. Upon completion, the test vehicles were electrically tested to determine if any of the feedthroughs were open.

The single-printed feedthroughs showed at least one open in all but the feedthroughs with the 12-mil holes in the 20-mil square pads. The double-printed feedthroughs showed no opens in any of the feedthrough configurations.

Next, each of the double-printed feedthrough configurations were cross-sectioned. The cross sections showed that all four feedthrough configurations provided complete metallization coverage within the holes.

Two of the tested feedthroughs met the goal of fitting within a 10-mil thick film conductor line. The feedthroughs that utilized an oval-shaped hole fit in a pad that is a maximum of 10 mils wide.
Discussion

Scope and Purpose

The purpose of this investigation was to determine if thick film feedthroughs could be printed utilizing smaller hole sizes than previously used. The goal was to develop a thick film feedthrough small enough to fit within a typical thick film conductor line 10 mils wide. This type of feedthrough could be used to design two-sided hybrid microcircuits with densities greater than was previously feasible.

A thick film feedthrough test vehicle was designed and fabricated that incorporated several new feedthrough configurations. Upon completion, the test vehicles were electrically tested for continuity. Cross sections of each of the feedthrough configurations were made to visually examine the results.

Activity

Background

Thick film feedthroughs have either been the single-hole or the three-hole cluster style. Single-hole feedthroughs have had hole diameters between 22 and 31 mils. Three-hole cluster feedthroughs have three 10-mil holes that are centered on a 22-mil diameter circle (refer to Figure 1). These feedthroughs usually are centered on a 60-mil square conductor pad.

These feedthrough designs offer advantages in their ease of fabrication and inspection but require a substantial amount of area on a thick film network. A feedthrough was needed that requires less space and ideally could be contained within a 10-mil thick film conductor line.

Approach

A feedthrough test vehicle was designed that incorporated four new feedthrough configurations on the same thick film network. The four sizes chosen were considered the most likely to produce acceptable results based on past experiences. Table 1 shows the chosen feedthrough configurations.

The 12-mil and 10-mil hole feedthroughs were designed in the single-hole configuration with pad sizes smaller than previously done. The 6 x 12-mil and 6 x 9-mil hole feedthroughs are oval-shaped holes. The oval shape allows for a narrower feedthrough that could be placed within a 10-mil conductor pad, while still maintaining a hole area sufficiently large...
Table 1. Investigation Sample Size

<table>
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<th>Feedthrough Hole/Pad Size</th>
<th>Quantity</th>
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<tr>
<td></td>
<td>Single Printed</td>
</tr>
<tr>
<td>12-mil/20 x 20-mil</td>
<td>400</td>
</tr>
<tr>
<td>10-mil/15 x 15-mil</td>
<td>370</td>
</tr>
<tr>
<td>6 x 12-mil/10 x 35-mil</td>
<td>160</td>
</tr>
<tr>
<td>6 x 9-mil/10 x 25-mil</td>
<td>160</td>
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enough to pull thick film ink through during the printing process.

A series of each of the feedthrough configurations was connected on the test vehicle thick film network so that a continuity test loop was formed (see Figures 2 and 3). This permitted probing the first and last feedthroughs, of a type, to determine if any of the printed feedthroughs were open.

Figure 2. Feedthrough Test Vehicle Frontside

The feedthrough test vehicles were printed on 40-mil ceramic using gold conductor paste. Five were single-printed (frontside and backside feedthrough pads printed once). Ten were double-printed (frontside and backside feedthrough pads printed twice). These parts produced the quantity of feedthroughs shown in Table 1.

Results

The completed test vehicle's continuity test loops were electrically analyzed to determine if any of the feedthroughs were open.

The single-printed feedthroughs showed at least one open in all but the feedthroughs with the 12-mil holes in the 20-mil square pads. The double-printed feedthroughs showed no opens in any of the feedthrough configurations.

Next, each of the double-printed feedthrough configurations was cross-sectioned in both the axes parallel and perpendicular to the conductor line. Figures 4 through 7 are photographs showing the results of the cross-sectioning.

The cross sections showed that all four feedthrough configurations provided complete metallization coverage within the hole. There was no evidence of a possible open circuit condition caused by conductor coverage.
Feedthroughs made using a 12-mil hole in a 20-mil square pad.

Feedthrough cross section parallel to the conductor line axis.

Feedthrough cross section perpendicular to the conductor line axis.

Figure 4. Feedthroughs Made Using a 12-mil Hole in a 20-mil Square Pad
Feedthroughs made using a 10-mil hole in a 15-mil square pad.

Feedthrough cross section parallel to the conductor line axis.

Feedthrough cross section perpendicular to the conductor line axis.

Figure 5. Feedthroughs Made Using a 10-mil Hole in a 15-mil Square Pad
Figure 6. Feedthroughs Made Using a 6 x 12-mil Oval-Shaped Hole in a 10 x 35-mil Rectangular Pad

Feedthroughs made using a 6 x 12-mil oval-shaped hole in a 10 x 35-mil rectangular pad.

Feedthrough cross section parallel to the conductor line axis.

Feedthrough cross section perpendicular to the conductor line axis.
Feedthroughs made using a 6 x 9-mil oval-shaped hole in a 10 x 25-mil rectangular pad.

Feedthrough cross section parallel to the conductor line axis.

Feedthrough cross section perpendicular to the conductor line axis.

Figure 7. Feedthroughs Made Using a 6 x 9-mil Oval-Shaped Hole in a 10 x 25-mil Rectangular Pad
ink not being completely pulled through the hole. Many of the feedthroughs made using a 6 x 9-mil oval-shaped hole did close shut with conductor ink; however, cross sections of these holes did not show the potential for an open circuit.

**Accomplishments**

A test vehicle was designed that incorporated four new feedthrough configurations. The feedthroughs included 12-mil holes in 20-mil square pads, 10-mil holes in 15-mil square pads, 6 x 12-mil oval-shaped holes in 10 x 35-mil rectangular pads, and 6 x 9-mil oval-shaped holes in 10 x 25-mil rectangular pads.

Continuity test loops made using the four feedthrough configurations showed open circuits on all but the 12-mil holes when the feedthroughs were single-printed and no opens when the feedthroughs were double-printed.

Cross sections of the double-printed feedthroughs verified that there was complete metallization coverage within the holes. It was observed that the feedthroughs made using 6 x 9-mil oval-shaped holes closed shut many times with metallization, but this did not seem to affect feedthrough integrity.

Two of the tested feedthroughs met the goal of fitting within a 10-mil thick film conductor line. The feedthroughs that utilized an oval-shaped hole fit in a pad that is a maximum of 10 mils wide.

**Future Work**

A functional thick film network has been designed utilizing feedthroughs with 6 x 9-mil oval-shaped holes in 10 x 25-mil pads. The two-sided multilayer network contains three conductor layers on each side and has over 128 of the 6 x 9-mil oval-shaped feedthroughs. The network has been designed and will be built as part of a separate project. The results will be reported upon completion.
END

DATE 4/18/94

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