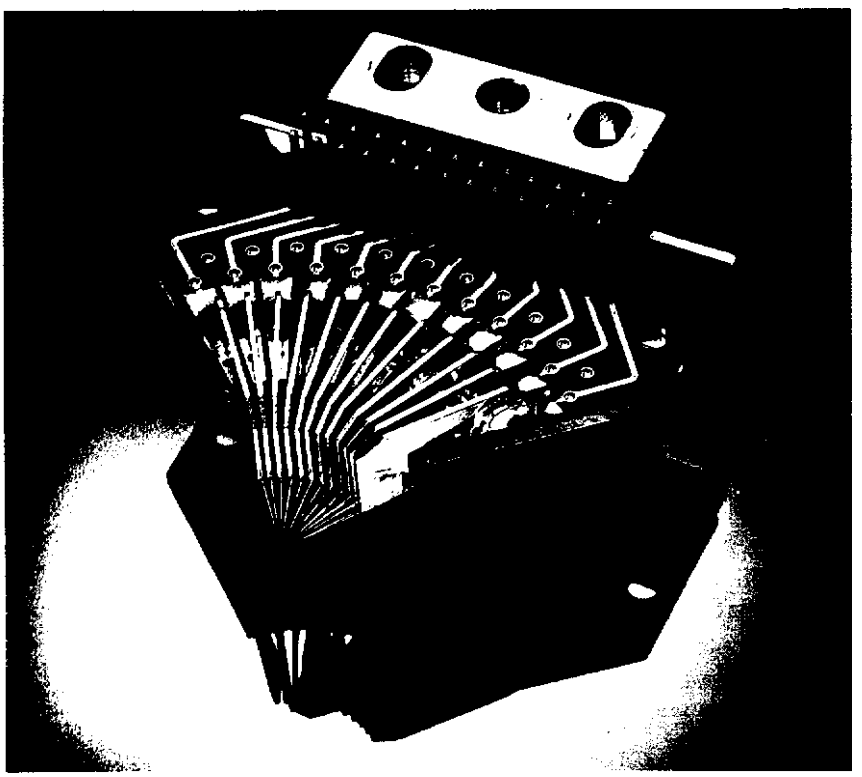
Application Note

# Layout rules for WPH-900 series probes

## A device layout guide for the efficient use of CMI's WPH-900 series probes

**This Application Note provides information on mechanical and electrical layout "rules" for the Cascade Microtech WPH-900 series needle probes. This knowledge will help you achieve efficient measurements in conjunction with the full line of Cascade Microtech coplanar GHz probes.**



CASCADE™ MICROTECH

CASCADE MICROTECH®

# Layout rules for WPH-900 series probes

## Introduction

Cascade Microtech WPH-900 series probes are designed for supplying bias voltages, controlling signals. and other low frequency uses. The WPH-900 series probes are intended to work in conjunction with Cascade Microtech coplanar GHz probes.

This Application Note presents information for correctly laying out ICs, hybrids, and other substrates that can use Cascade Microtech WPH-900 series probes. Please refer to the Cascade Microtech application note "Layout Rules for GHz Probing" for layout rules specific to GHz probing.

Figure 1 and the cover photo show a typical WPH-900 probe. The mounting block dimensions are identical with the Cascade Microtech WPH-100, 200, 300, 400 and 700 series probes, allowing them to be physically interchangeable.

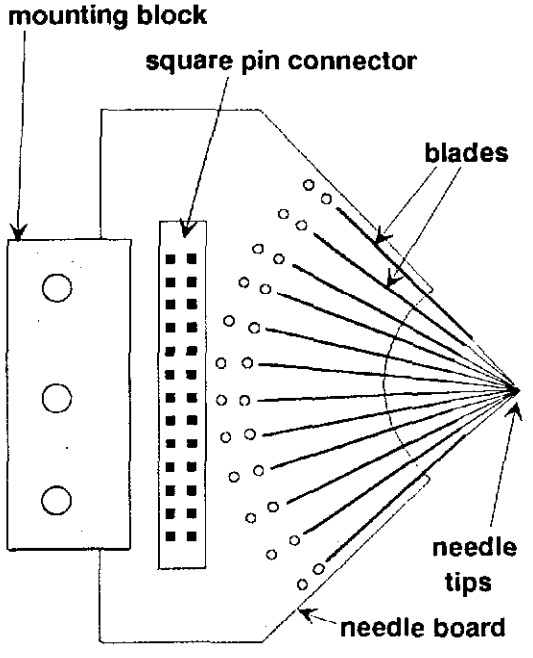



**Fig. 1 WPH-900 probe components.**

During construction the individual dc blades (Fig. 2) are temporarily fitted to the needle board. The needles are then bent to properly contact a row of bond pads. The row of pads can be either perpendicular (Fig. 3) or parallel (Fig. 4) to the probe axis.

Characteristics of a dc blade:

- Preload (force) – 2 grams/mil, per contact
- Tip diameter – 50 $\mu$m
- Material – beryllium copper

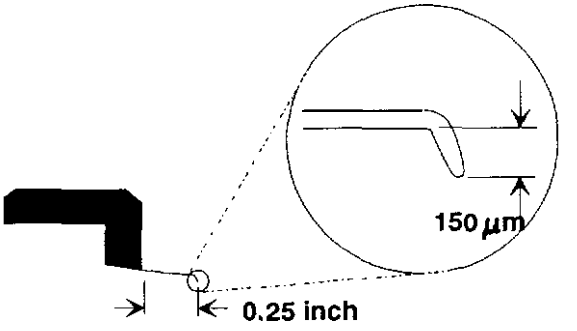



**Fig. 2 individual dc blade dimensions.**

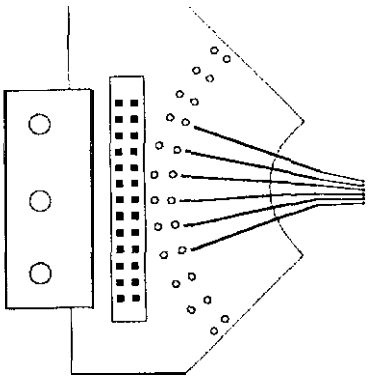


**Fig. 3 WPH-906 probe contacting one row of pads (≈250 x 250 $\mu$m), perpendicular to probe axis.**

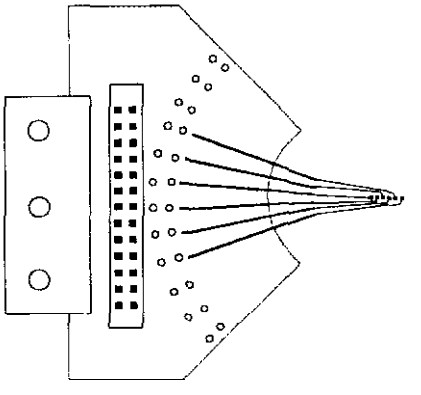


**Fig. 4 WPH-906 probe contacting one row of pads (≈250 x 250 $\mu$m), parallel to probe axis.**

In some cases the needles will have to be bent several times to clear other components or other probes. After fitting, the dc blades are soldered in place.

A typical layout is shown in Figure 5, with GHz probes contacting the substrate on the left and right, and the WPH-912 probes (12 needles) contacting the substrate on the top and bottom. The pads are on the substrate periphery and are easy to contact, with little risk of probe collision. Note that this is a relatively standard layout, and is a good starting footprint.

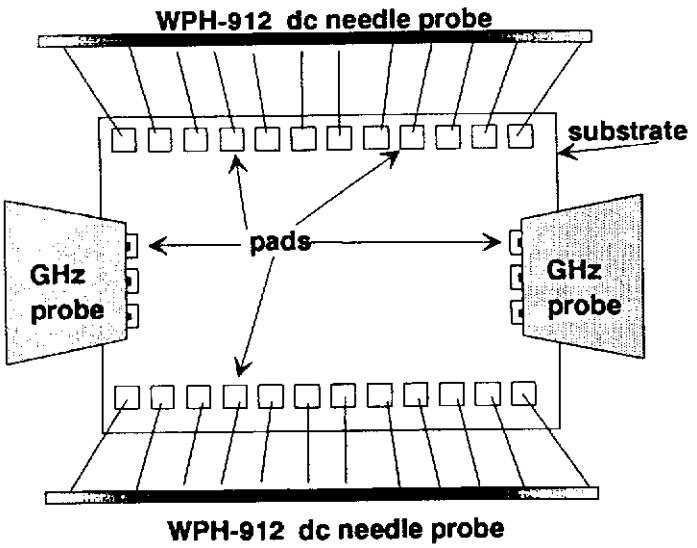



Fig. 5 Typical substrate pad layout for testability.

# Mechanical layout rules

The following layout rules describe mechanical requirements related to spacing, clearance, etc. These rules give minimum and maximum values which are conservative, and generally applicable to probing with an autoprober.

In some situations your requirements may require tight dimensions which violate the following rules. If that is the case, please see the following SPECIAL PROBE CONFIGURATIONS section.

Use the following conservative rules unless absolutely necessary. Your layouts will be easier to probe and the WPH-900 probes will usually cost less than if you violate the rules.

**Rule 130 Pad size** The minimum pad size for landing WPH-900 probes is 100 x 100 μm (Fig. 6).

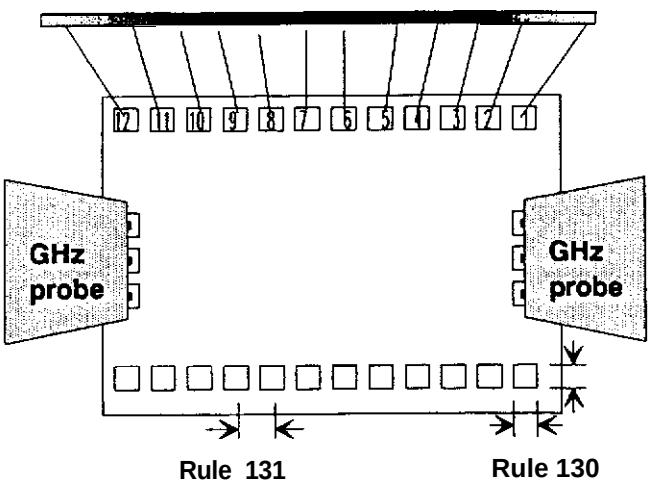



Fig.6 Rules 130 and 131, minimum pad size and pad pitch.

**Rule 131 Pad pitch** The minimum center-to-center pad spacing is 150 μm (Fig. 6). Note that 100 x 100 μm pads with a 150 μm pitch is a standard in both the silicon and GaAs Industry. These pad dimensions are relatively easy to probe with current autoprobers, so are recommended as starting values.

**Rule 132 Passivation window** The minimum passivation window size is 96 x 96 $\mu$m (Fig. 7). This size corresponds to the minimum pad size of 100 x 100 $\mu$m. Note when using pads smaller than 100 x 100 $\mu$m, the passivation window minimum size is still 96 x 96 $\mu$m, allowing sufficient space in the passivation for the needle to contact the pad.

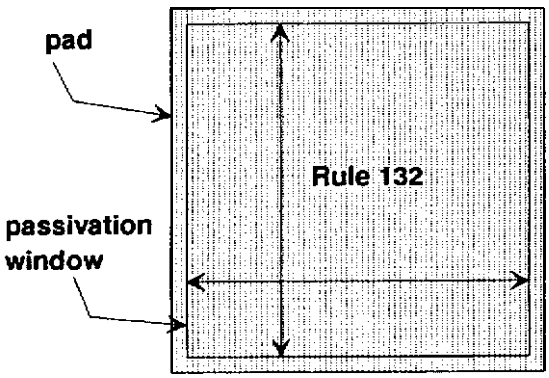



Fig. 7 Rule 132, passivation window size.

Rule 133 Maximum number of pads per probe
*Perpendicular:* The maximum number of pads per probe is 12, when the pads are aligned perpendicular to the probe needles (Fig. 8).

*Parallel:* The maximum number of pads per probe is six, when the pads are aligned parallel to the probe needles (Fig. 9). If more than six are required, see the following SPECIAL PROBE CONFIGURATIONS section.

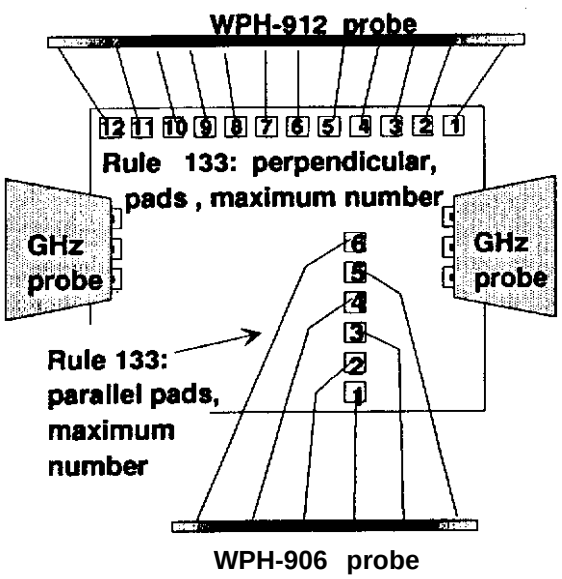



Fig. 6 Rule 133, maximum number of pads per probe.

Rule 134 Maximum pad span
*Perpendicular:* The maximum center-to-center spacing is 4,445 $\mu$m between end pads that are contacted by one WPH-900 probe (Fig. 9). when a line of pads are perpendicular to the needles.

*Parallel:* The maximum center-to-center spacing is 2,500 $\mu$m between the end pads that are contacted by one WPH-900 probe (Fig. 9), when the pads are parallel to the needles.

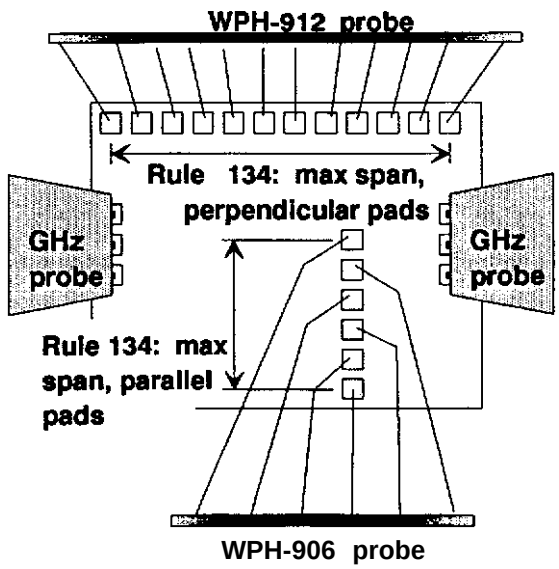



Fig. 9 Rule 134, maximum pad span; and Rule 135, all pads must be collinear.

Rule 135 All pads collinear All pads contacted by a single WPH-900 probe must be in a straight line, either parallel or perpendicular to the probe axis (Fig. 9). Exceptions to this rule are allowed, see the following SPECIAL PROBE CONFIGURATION section.

Rule 136 All pads planar All pads contacted by a single WPH-900 probe must be in the same plane. Exceptions to this rule are allowed, see the following SPECIAL PROBE CONFIGURATION section.

**Rule 137 Vertical clearance** The maximum vertical feature height is 100 $\mu$m (Fig. 10). This means that no feature of the DUT (bond wire, die, etc.) can extend more than 100 $\mu$m above the substrate. This rule applies to all features located near the path of the dc needles. Exceptions to this rule may be allowed, see the following SPECIAL PROBE CONFIGURATION section.

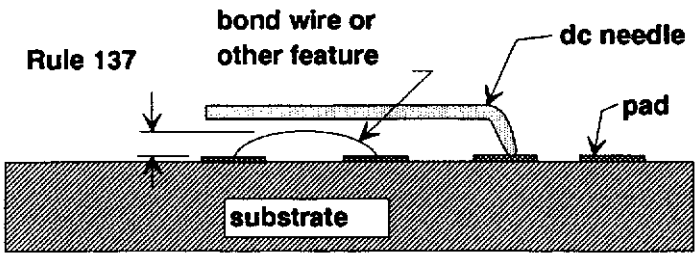



Fig. 10 Rule 137, vertical clearance requirements.

**Rule 139 Horizontal clearance** The minimum horizontal clearance between a pad probed by a WPH-900 probe and any other probe or fixture contacting the DUT. or any other obstruction, is 200 $\mu$m (Fig. 11). Exceptions to this rule are not usually allowed and will be very expensive.

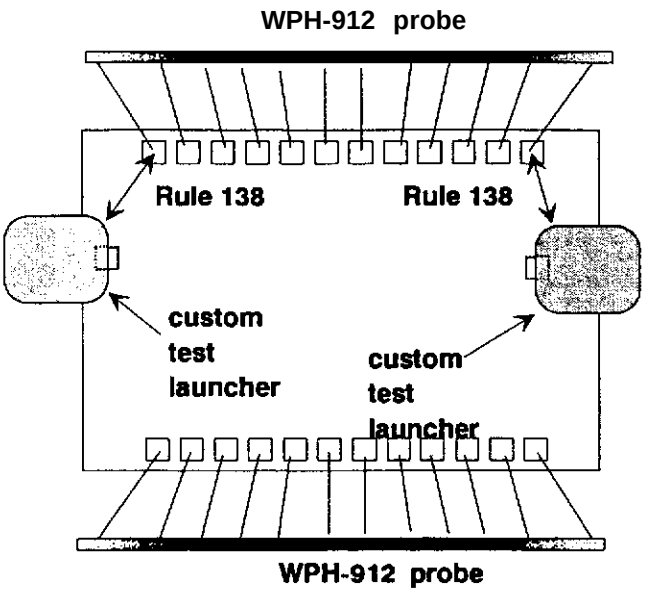



Fig. 11 Rule 138, horizontal clearance requirements.

**Rule 139 Pad spacing with GHz probes** The minimum center-to-center pad spacing is 200 $\mu$m (Fig. 12), when the WPH-900 series probe Is adjacent to a WPH-0xx, -100, -200, -300, -400, -700, RTP-xxx series probe.

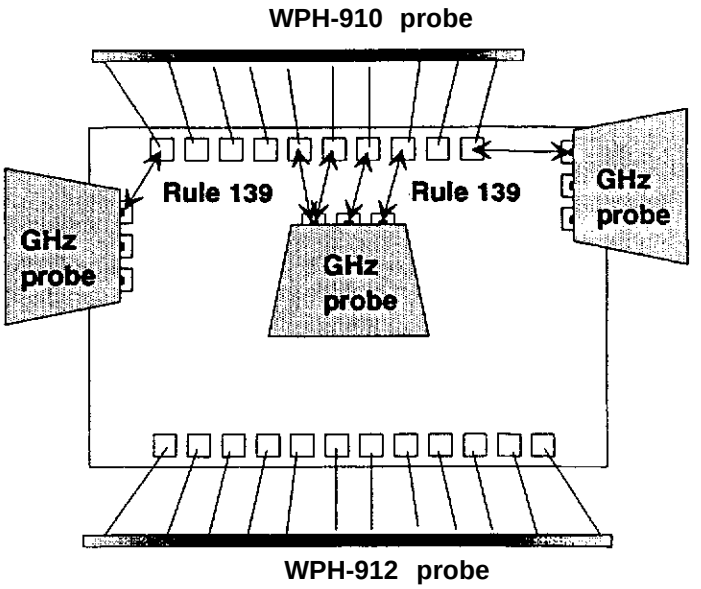



Fig. 12 Rule 139, pad spacing requirements with adjacent GHz probes.

# Electrical rules

**Rule 230 Maximum dc current** The maximum dc current per contact is 0.5 ampere, making and breaking contact; 1 ampere after contact has been made. Note that in some cases current flowing through one needle may be the sum of the currents in the other needles. The one-needle total should not exceed the maximum rated current.

**Rule 231 Needle model is 8 nH inductor** An 8 nH inductor can be used as a first-order model for each WPH-900 needle contact, including the common or ground contacts. (Do not expect the WPH-900 series probes to provide high-frequency performance.)

# Special probe configurations

## (Exceptions to the rules)

Special probes cost more than standard ones. However, there are applications for which the above rules are too restrictive, or the choice is to take more risks. The following is a general discussion of what Is possible and what is not possible.

It is recommended that Cascade Microtech be involved early in the design cycle:

1. Preliminary layout Complete a preliminary layout.

2. Send layout Send the preliminary layout (and all other pertinent information, see below) by fax to Cascade Microtech.

3. CMI will review Cascade Microtech will review the information, make recommendations, and/or send a quotation.

If a risky layout design is completed without checking with Cascade Microtech, it could add greatly to the cost of the probes, or be impossible to make WPH-900 probes which will meet the requirements. In a nearly impossible situation Cascade Microtech may quote a best-effort (no warranty) probe only. All modifications will then be made at an hourly rate, plus materials.

**Pad size and spacing (Rules 139 & 131)** Smaller pads can often be accommodated, as well as a smaller pitch. In-line pads are preferred if the smaller pad size is required. This will make the probe construction and alignment easier.

**Passivation window (Rule 132)** Passivatlon windows of less than 96 x 96 mm are usually acceptable.

**Maximum number of pads per probe (Rule 133)** The maximum number of dc needles per probe, regardless of configuration, is 12.

**Maximum pad span (Rule 134)**

*Perpendicular:* The maximum center-to-center spacing is 4,445 µm between end pads that are contacted by one WPH-900 probe (Fig. 9), when a line of pads are perpendicular to the needles.

**Note** There are no exceptions to the maximum 4,445 mm center-to-center spacing.

*Parallel:* The maximum center-to-center spacing is 2,500 µm between the end pads that are contacted by one WPH-900 probe (Fig. 9), when the pads are parallel to the needles. The 2,500 µm between the end pads can be larger, depending on the layout.

**Non-collinear pad layout (Rule 135)** Randomly located pads are acceptable, provided they meet size and spacing requirements (Rules 130 and 131) and there is sufficient room to space the needles.

**Non-planar pads (Rule 136)** WPH-900 probes can usually be built to accommodate 100 µm of non-planarity between adjacent pads. Cascade Microtech must have a sample from which to construct the probe- no exceptions.

**Vertical clearance (Rule 137)** Additional vertical clearance can be obtained in some situations. Cascade Microtech must review every situation-send a topography map of your test substrate. A sample is required, with all components mounted, from which to construct the probe- no exceptions.

**Horizontal clearance (Rule 136)** Special bends and other tricks to route the needles by obstructions can sometimes be done, but is always expensive. Send complete details and samples for evaluation.

**Pad spacing to adjacent GHz prober (Rule 139)** A center-to-center pad spacing less than 200 µm can sometimes be obtained, particularly if the WPH-900 probes are contacting a simple, single row of pads.

# Required information

The following information is required to order a WPH-900 series probe:

## Standard probes (follows all layout rules)

1. Pad layout drawing Provide a pad layout drawing, with all dimensions referenced to one corner. The drawing should identify all probes and fixtures that will contact the substrate under test. Identify and give dimensions of all components and features which extend 100 µm above the substrate surface.

2. Sample A sample is preferred.

## Special probes (layout violates one or more rules)

**1. Pad layout drawing** Provide a pad layout drawing, with all dimensions referenced to one corner. The drawing should identify all probes and fixtures that will contact the substrate under test. Include model numbers and dimensions as appropriate to facilitate probe construction.

**2. Sample** Actual finished sample is required if any of the following rules are violated:

- Rule 136, Pad planarity
- Rule 137, Vertical clearance
- Rule 138, Horizontal clearance
- If you have a TW (truly weird) layout

# Options

**Edge sensor** The edge sensor is a normally closed or open switch that is actuated by the wafer's top surface. The edge sensor takes two dc blade positions on the needle board. Specify where the edge sensor should land on the substrate.

**Kelvin sense** This is often simply two needles landing on the same pad. While it is possible to construct WPH-900 probes In this way, it is preferable to lay out Kelvin sense circuits as shown in Fig. 13 (top). This configuration is preferable because It is easier to construct, will usually cost less, and will extend the Kelvin sensing up to the circuit on the substrate.

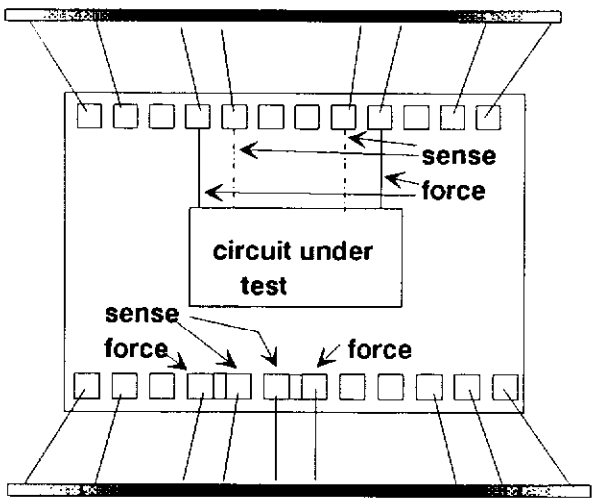



**Fig. 13 Recommended Kelvin sense layouts.**

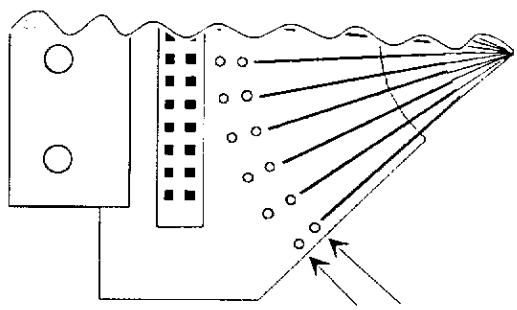
If you want to do Kelvin sensing just to the substrate edge, the recommended layout is shown in Fig. 13 (bottom), where two standard-size pads are connected together, one being the force pad, and the other the sense pad.

**Adding components on the WPH-900 probes** Resistors and capacitors are often added to minimize oscillations. Soldering anything to a WPH-900 series needle board is risky, because the blades are soldered to the needle board with standard 63/37 solder (melting point 183° C). The blades will be misaligned if the solder melting temperature is exceeded.

Soldering to the blades will void the warranty. The recommended procedure is to add components to the needle board, just back of the blades, as shown In Fig. 14. Special low melting point solder should be used, with a melting point of less than 150° C. The soldering iron should be operated at a lower than normal temperature.

If it is necessary to solder components directly to the blades, it is recommended to (1) use a low temperature solder, (2) use a low-temperature soldering iron, and (3) place a suitable heat sink to the blade being soldered to. Note that this will void the warranty.

**Note** WPH-700 multicontact custom probe heads are recommended for critical bypassing applications requiring low Inductance.



**All additional components should be placed in these holes;**
**Do not solder to the blades!!**

**Fig. 14 Adding components to needle boards.**

**Contributors** Arthur Fraser is the applications manager at Cascade Microtech; Vicky Murray is a senior product technician involved in construction of WPH-900 probes; Janise McMenamin is the new-product-introduction coordinator.