User Guide

Pyramid Probe Core

PN 151-852, Revision 10, June 24, 2019

FormFactor™

User Guide

Pyramid Probe Core

PN 151-852, Revision 10, June 24, 2019

FormFactor™

Important Notice

While the information contained herein is believed to be accurate as of the date hereof, no express or implied representations or warranties are made with respect to its accuracy or completeness. FormFactor, Inc., and its subsidiaries disclaim liability for any inaccuracies or omissions. All information is subject to change without notice.

Users are required to read and follow carefully all safety, compliance and use instructions. Users assume all loss and liability arising from the use of products in any manner not expressly authorized. The conditions and methods of use of products and information referred to herein are the entire responsibility of the user and, to the maximum extent permitted by applicable law, FormFactor, Inc., and its subsidiaries shall not be liable for any damages, losses, costs or expenses arising out of, or related to, the use thereof.

No license, express or implied, by estoppel or otherwise, under any intellectual property right is granted in connection herewith. Users shall take all actions required to avoid intellectual property infringement.

Contents

Before You Begin

About This Guide

Welcome to the *Pyramid Probe Core User Guide*. This guide describes proper handling and inspection procedures, operational considerations, best practices and troubleshooting suggestions, as well as cleaning and maintenance instructions.

Notational Conventions

This manual uses the following conventions:

NOTE

Note is used to indicate important information about the product that is not hazard related.

CAUTION

Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

WARNING

Warning is used to indicate the presence of a hazard which can cause substantial personal injury or property damage if the warning is ignored.

DANGER

Danger is used to indicate the presence of a hazard which will cause severe personal injury, death or substantial property damage if the warning is ignored.

For More Information

More information may be available from these sources:

- FormFactor’s website at www.formfactor.com.
- Your probe station user guide
- Release Notes
- If you purchased your FormFactor product from a third-party vendor, you can contact that vendor for service and support.

Chapter

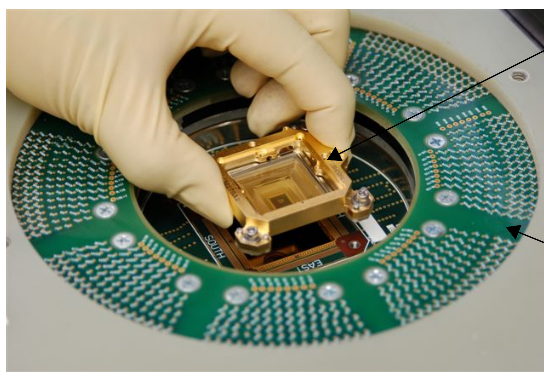
1 Product Overview

Pyramid Probes

Each Pyramid Probe design is customized for the configuration and specifications of your specific DUT (device under test). Pyramid Probe cores are robust and well suited to high performance production wafer probing. They can be used in high speed digital, mixed signal, RF and DC parametric applications.

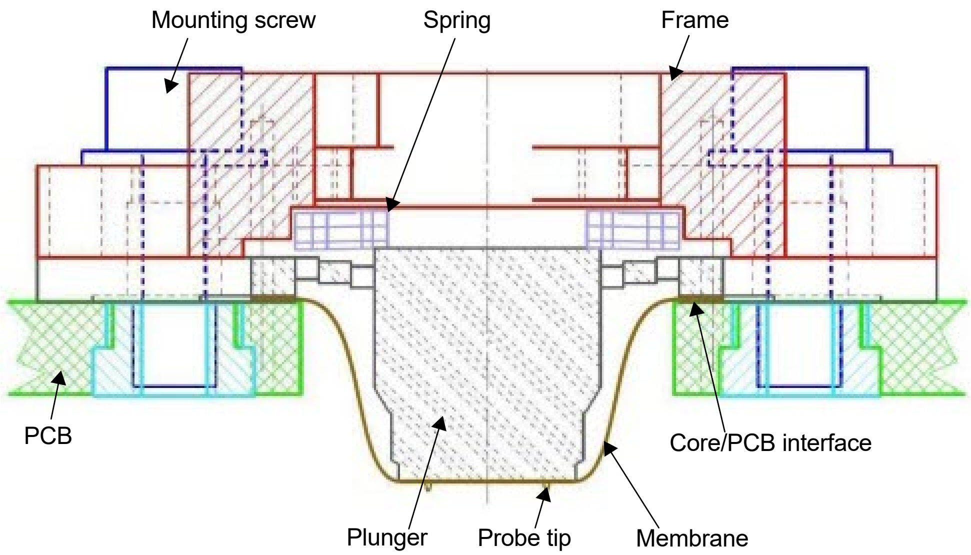
Pyramid Probe Card

Pyramid Probe Cards are composed of a printed circuit board (PCB) and a field replaceable Pyramid Probe core.



Pyramid Probe Core

The Pyramid Probe core is composed of a metal frame, plunger assembly and a flexible, polyimide thin film membrane. The core mounts to the tester side of the PCB with four screws. The membrane extends through the PCB.

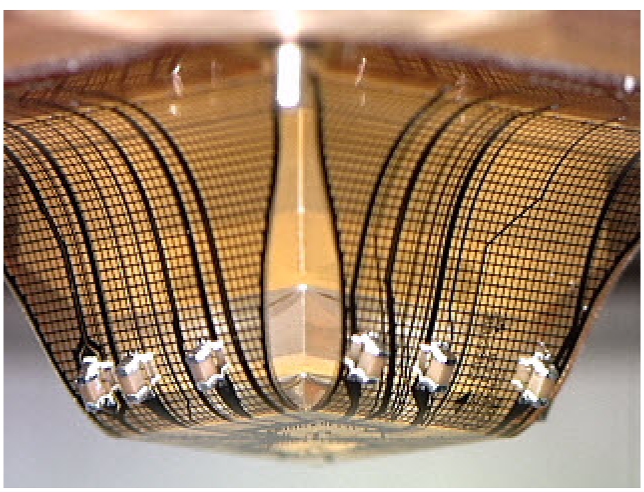


The die contact area is adhered to the plunger assembly with a compliant adhesive layer. The size of the plunger sets the probe tip depth and the size of the area parallel to the wafer. The springs between the plunger and the frame provide the contact force.

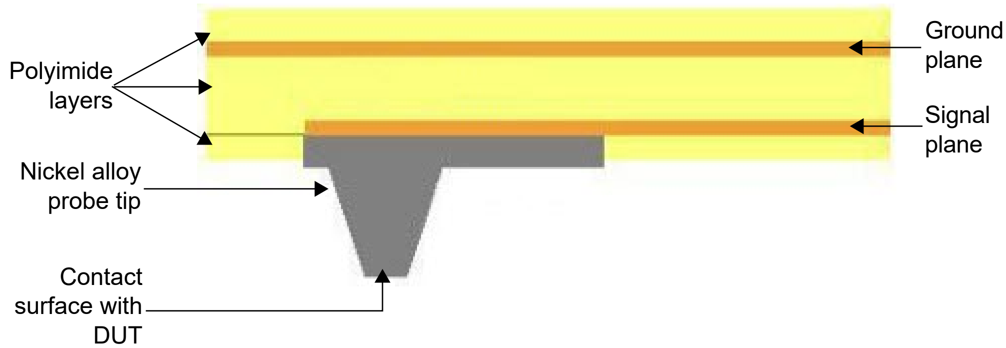
Because the polyimide membrane is not in tension, shape deformation due to stretching does not occur. Non-oxidizing nickel alloy probe tips provide contact with the DUT, and are also used to create the contact interface with the PCB. Pads of the same metal are used to attach SMT (surface mount) components to the membrane.

The name “Pyramid Probe” refers to the shape of the membrane after assembly.

Pyramid Probe core for a dual-DUT RF design



The Pyramid Probe thin film is made up of five layers. Two metal conductor layers, or planes, are surrounded by three dielectric layers made of polyimide. The ground plane is located farther from the DUT and is primarily a mesh, made solid where required. It can be used either as a ground grid or as a second signal layer. The signal plane is located nearer to the DUT.



Chapter

2 Receiving and Unpacking

Package Contents

Probe cards are precision devices. Pyramid Probe cores and cards must be handled, installed and maintained carefully.

NOTE

Read the directions shipped with your core carefully before unpacking or handling it. See *Visual Inspection and Handling on page 11* *for more information.*

Your shipment will arrive in a box containing the Pyramid Probe core(s) and/or PCB(s).

Probe core shipping box

The following items are also included in the shipping box:

- Packing list
- Warning sheet
- Cardboard suspension carrier securing the probe core box(es)

Keep the original shipping box. It will be required if you need to return the product for service.

Core Box(es)

Pyramid Probe cores are shipped mounted in a sealed plastic container, referred to as a core box.

Only authorized personnel should unpack the cores. *See* Remove the Core From the Core Box on page 15 for proper unpacking procedures.

When not installed on a probe card, cores should be stored securely in the core box for mechanical protection. *See* Storing the Probe Core on page 24 for proper core storage procedures.

PCB Box(es)

CAUTION

To avoid injury, use caution when opening plastic PCB shipping containers.

Suspension Carrier

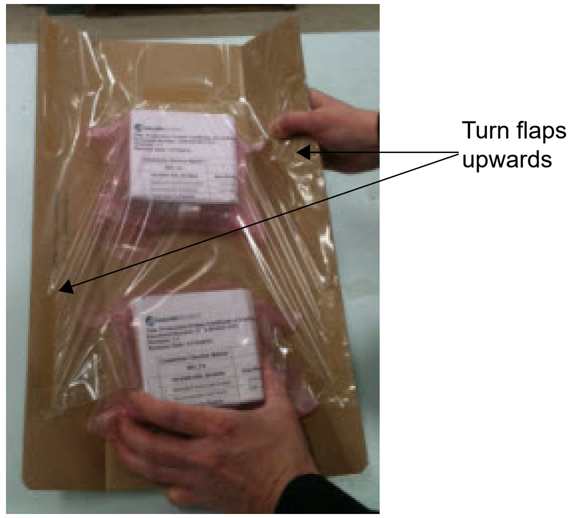
The core box(es) will arrive secured in a cardboard suspension carrier.

NOTE

Do not cut or tear the plastic on the suspension carrier.

To safely remove the core boxes from the carrier:

1. Rotate the flaps on the cardboard suspension carrier upwards to release the plastic securing the core boxes.



2. Slide the core boxes carefully out from under the plastic.

Follow all safety warnings and precautions to ensure proper core performance and personal safety.

Pyramid Probe Cleaning Brush

Brushes designed specifically for cleaning probe tips are included with your original shipment. Be sure to keep these brushes with the core.

For additional brushes, contact your local applications or sales support.

Data Package

To access further information such as membrane drawings, design capture forms, user guides, cleaning instructions, and other relevant data, visit the Product Data Package Resource Center on the FormFactor website.

Certificate of Conformance

The Certificate of Conformance contains the specifications for your Pyramid Probe. Keep this document for your records. These values are unique to each individual Pyramid Probe. The serial number of the specific Pyramid Probe is included in the report.

Inspection Date: XX/XX/XX

Customer Device Name	Integrated Part Number
Enter device name here	**P/N : XXX-XXXX-XX S/N : XXXXXX**

Core Parameters	CorePNSN DMC	Specification Range	Final Inspection Results
	1. Electrical First-to-Last Contact	x.xx mils / xx um	x.xx mils / xx um
	2. Physical Planarity	x.xx mils / xx um	4.00 mils / 100 um
	3. Recommended Over-travel	x.xx mils / xx um	
	4. Maximum Over-travel	Not to Exceed: x.xx mils / xx um	
	5. Probe Face Co-Planarity	.80 mils / 20µm	x.xx mils / xx um
	6. Probe Tip Alignment	X: ± 10 µm Y: ± 10 µm	Pass or Fail
	7. Probe Depth (Tester side of PCB)	+ 300 µm / 12 mils	Pass or Fail
	8. RF Performance	Return Loss Insertion Loss	Pass or See Waiver or N/A
	9. Contact Resistance	≤ x Ω	Pass or Fail
	10. Leakage	≤ 7000 pA @ 3V	Pass or Fail
	11. Low Leakage		N/A or See Low Leakage Report
	12. Edge Sense	1 to 2 mils / 25 to 50µm	x.xx mils / xx um
	13. ID Resistor Value	xx + 1%	xx
	14. Required components installed	—	Pass or Fail

Board Parameters	Board PNSN DMC	Specification Range	Final Inspection Results
	15. RF Impedance	+/-80 mRho	Pass or See Waiver or N/A
	16. Low Leakage		N/A or See Low Leakage Report
	17. Board Planarity	≤ 0.30 ppt	0.xx ppt
	18. ID Resistor Value	xx + x.x %	xx
	19. Required components installed	—	Pass or Fail

All parts listed included in the certification have demonstrated compliance to CMI specifications. Any exceptions are noted below:

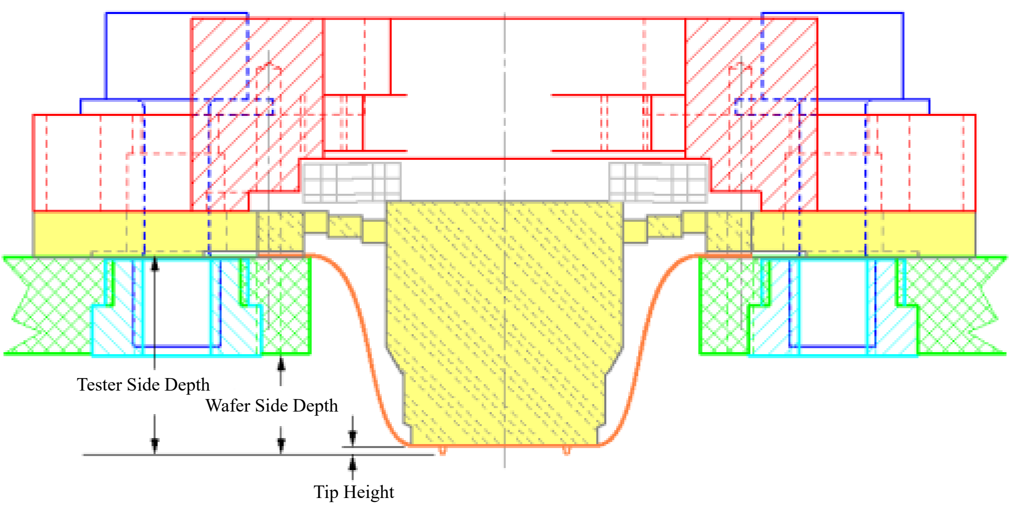
Exceptions: **None**

Toll Free: 1-800-550-3279
Tel: (503) 601-1122
Fax: (503) 601-1002
Sales@cmicro.com

Explanation of Outgoing Quality Report Parameters

Core Parameters

1. Electrical First-to-Last Contact	Electrical First-to-Last Contact (FTL) measurements are made by contacting a polished, flat chuck in a probe card analyzer. The specification range, the measured value, and whether the measured value passes or fails our specification are listed in this document. FTL is used as a pass/fail criteria for all but P800S core types.
2. Physical Planarity	Physical planarity is measured with a probe card analyzer. Measurements are made by making contact with each of the tips on a raised pin. The specification range, the measured value, and whether the measured value passes or fails the specification are listed in this document. Physical planarity is used as a pass/fail criteria on P800S type cores.
3. Recommended Overtravel	Recommended overtravel is a value that allows for good contact on all probe tips. It accounts for variations in system planarity and variations in measurement.
4. Maximum Overtravel	Maximum overtravel is the maximum overtravel recommended for use with this core. Please consult your Field Applications Engineer before exceeding this upper limit.
5. Probe Face Coplanarity	Probe face coplanarity measurements are used for cores where there are no probe tips in a quadrant that can be individually addressed with the probe card analyzer. The probe face coplanarity measurement is used to verify that the core face is parallel to the wafer.
6. Probe Tip Alignment	Probe tip alignment is measured with a probe card analyzer. It is a comparison between the locations of the tips on the probe and the design locations on the Design Capture Worksheet (DesCap). The specification range is shown.
7. Probe Depth	Probe depth is measured from the tester side of PCB. The final inspection results will state **PASS** (the specification range is shown).



8. RF Performance	RF Performance is measured with a network analyzer. The specification range depends on the performance requested in the Design Capture Worksheet. S-parameters vs. frequency for Return Loss and Insertion Loss are included in the measurement results with first articles.
9. Contact Resistance	Path resistance is measured on the probe card analyzer. It is a combination of contact resistance, trace resistance on the membrane and trace resistance on the PCB. For larger and fine pitch cores, the membrane trace resistance can dominate.
10. Leakage	Leakage is measured on the probe card analyzer. The specification limit and test conditions are listed in the specification range.

11. Low Leakage	Low Leakage is measured on the Low Leakage Station. The specification limit and test conditions will be provided on the Low Leakage Report.
12. Edge Sense	If edge sense is installed, the reported value is equal to the amount of travel after the first contact until the switch opens. The specification range is shown.
13. ID Resistor Value	If an ID resistor is installed, the specification will give the required value. The results will indicate the measured value.
14. Required Components Installed	Components are verified in three ways. First, they are checked on the probe card analyzer for both installation and value, when possible. Second, a visual inspection is performed. Finally, the value is checked by hand probing if the component is not able to be measured by the analyzer.

Board Parameters	
15. RF Impedance	RF Impedance is measured with a network analyzer. The Impedance Report includes the measurement results. The specification range is shown.
17. Low Leakage	Low Leakage is measured on the Low Leakage Station. The specification limit and test will be provided on the Low Leakage Report.
18. Board Planarity	Board planarity is a measurement (shown in parts-per-thousand [PPT]) of the tilt a PCB puts on a probe when installed. Board Planarity is not a measure of the flatness of the PCB. Rather, it is a measure of the planarity of the core mounting area with respect to the chuck or DUT. Many PCBs with stiffeners allow for native planarity adjustment by turning screws on the stiffener or by adding shims between the PCB and the stiffener.
19. ID Resistor value	If an ID resistor is installed, the specification will provide the required value. The results will then provide the measured value.
20. Required components installed	Components are verified in two ways. First, they are checked on the probe card analyzer for both installation and value, when possible. Second, if the analyzer is unable to measure the value, it is checked by hand probing.

Chapter

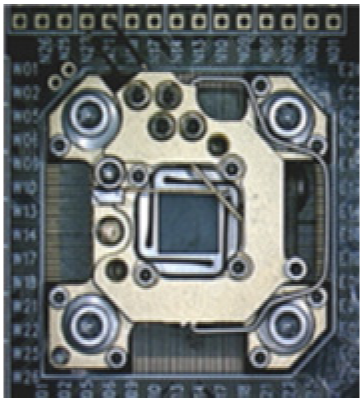
3 Visual Inspection and Handling

Probe Core Structure

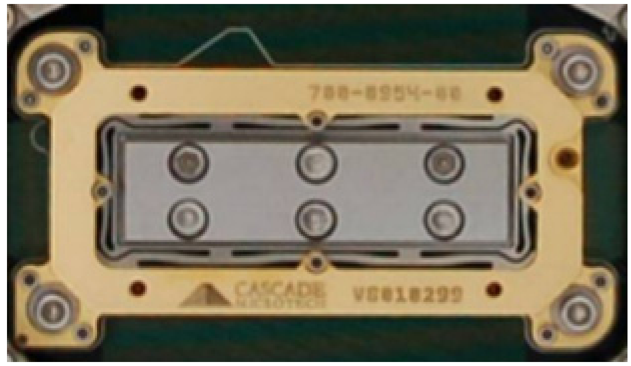
Pyramid Probe Cores are available in several different frame sizes. Some sizes have an option of either a plastic or steel plunger.

Tester Side

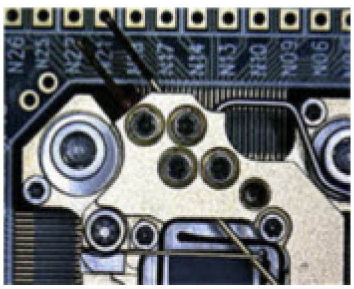
These elements are visible when viewing the wafer core from the top, also called the tester side.



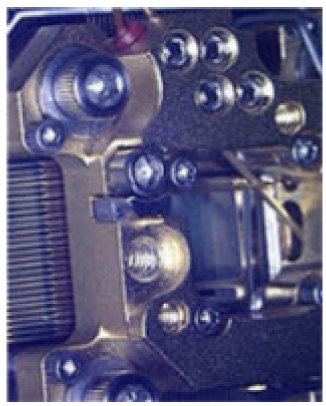
Entire probe core



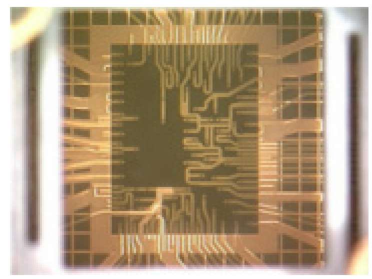
Entire P800-S core



Edge sense (if installed)



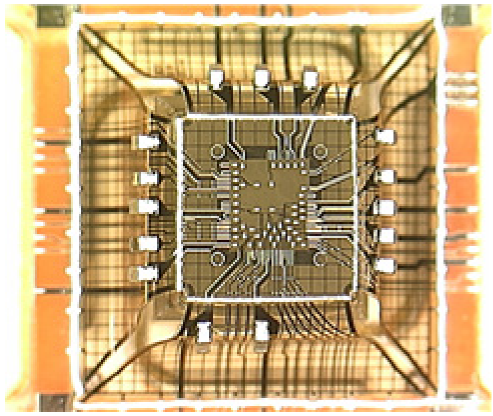
Edge sense screws



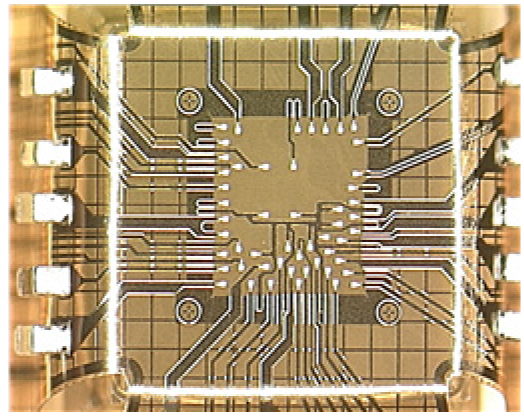
Core window

Wafer Side

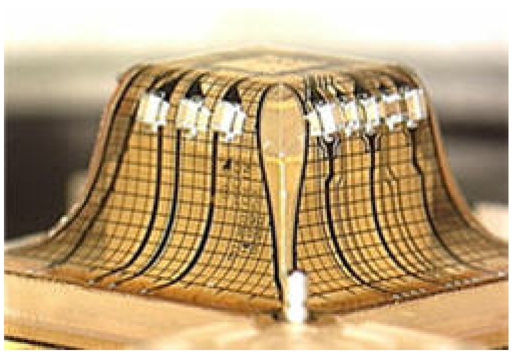
These elements are visible when viewing the wafer core from the bottom, also called the wafer side. The probe tip surface is referred to as the face, or wafer side. The angled sides of the membrane are called wings.



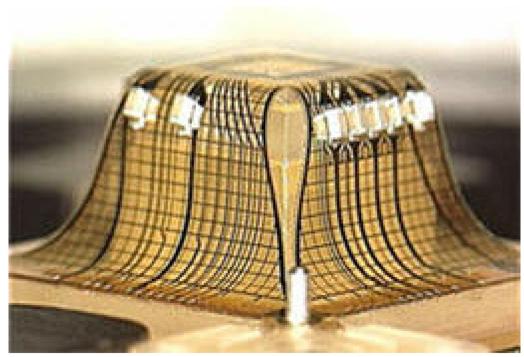
Entire membrane



Probe face (tips)



Wings: north & east



Wings: south & west

NOTE

Follow all safety warnings and precautions to ensure proper core performance and personal safety. We recommend wearing gloves when handling cores.

Incoming Inspection Process

Before a new core is put into use, a visual inspection should be performed to verify that the core is physically complete and undamaged. Procedures for installing the probe core into the probe card, removing the core from the probe card, and storing the core are described here.

CAUTION

When not installed on a probe card, cores should be stored securely in the core box for mechanical protection. Refer to Storing the Probe Core on page 24 for details on installing the core in the core box.

Tools required to complete these steps include:

- Probe card (for mounting the core)

- Probe core, in core box
- 64 in-oz x 3/32-inch torque wrench (for tightening mounting screws when mounting the core to the probe card)
- 3/32-inch hex wrench (or Allen wrench)
- Squeeze bottle containing IPA (isopropyl alcohol) or methanol. Use only methanol on low leakage applications.
- Cleaning brush

Verify Shipment Contents

1. Verify that the correct design has been shipped using the Membrane Layout drawing. The Title block contains an Item code. On the top side of the core frame is a laser engraved part number and serial number. These numbers should match.
2. Check for any loose screws in the core shipping box. If you find any loose screws, stop and contact a FormFactor Applications Engineer immediately. *Do not attempt to install or tighten any loose screws.* Note that there may not be screws in all possible locations on the core frame for your particular core.

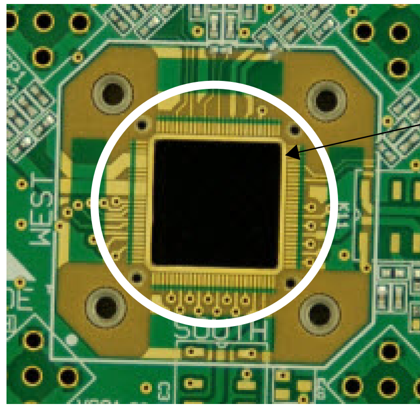
Clean the Interface on the Probe Card

Perform this step if you intend to install the core into the PCB for inspection.

CAUTION

Do not allow IPA to contact the board-to-coax solder joints, as it will alter the dielectric characteristics in the semi-rigid coax. It may take up to one (1) hour for the IPA to evaporate and board performance to return to within specifications.

1. Carefully clean any particles or filmy contaminants from the gold pads around the contact area using the brush provided. Most dust and lint can be removed with the brush.



Remove the Core From the Core Box

Always follow these procedures when handling the cores:

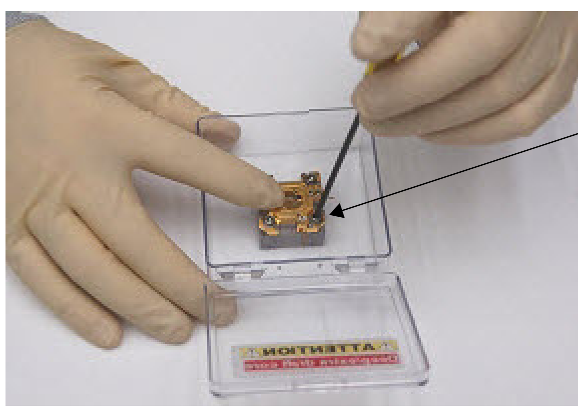
- Wear gloves when handling cores and boards.
- Handle the core by its frame only.
- Do not set the core face (tips) down on any surface
- Contact the edge sense pins only when connecting or disconnecting from the PCB.
- Do not bend the edge sense pins. Doing so can change the edge sense value.

To remove the core from the core box:

1. Hold the core in the box with one hand. With the other hand, use the 3/32-inch hex wrench to loosen the four captive screws from the mount in a crisscross manner.

NOTE

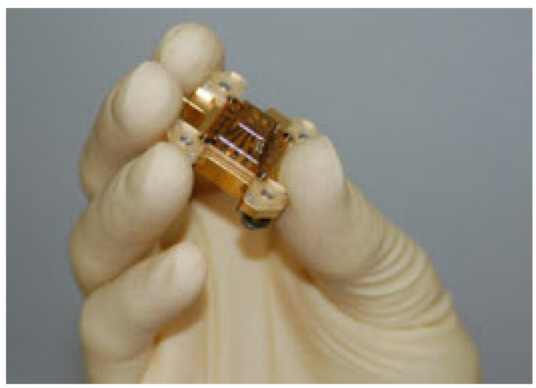
Loosen, but do not completely remove the screws.



2. Hold the core with one hand and the core box with the other. Gently lift the core, making sure not to touch the core to the mount or the edges of the box.

Perform an Unaided Visual (Gross) Inspection

1. Inspect for any tears in the membrane.
2. Ensure that the wings (sides) are not loose from the frame.
3. Confirm that probe tip area is undamaged.
4. Verify that all components are installed correctly and undamaged.



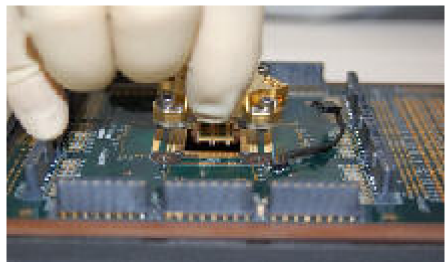
Install the Core in the Probe Card

Standard (non-P800-S)

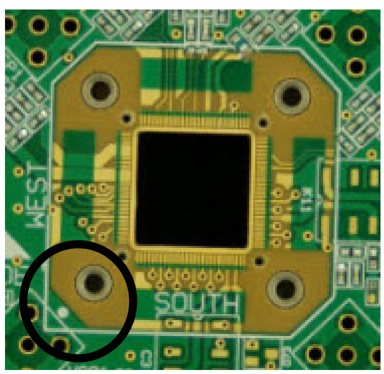
CAUTION

- *To avoid injury, use caution when opening plastic PCB shipping containers.*
- *Ensure adequate clearance under the probe card. The probe tips may protrude from the bottom of the card more than 315 mils (8 mm), and may be unprotected during handling.*

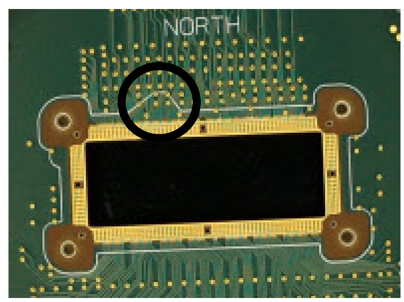
1. To orient the core, place it into the PCB, making sure the four alignment pins engage the alignment holes and the core sits flat on the card.



The core is oriented correctly when the core frame key matches the silkscreen outline on the PCB. The key is generally located in the lower left corner, with the exception of VLSR cores with edge sense, where it is located along the upper north quadrant.



Square core orientation - key is located in lower left corner



VLSR core with edge sense orientation - key is located along north upper edge

2. Use the 3/32-inch hex wrench to tighten the four mounting screws, finger-tight only, in a crisscross manner.
3. Use a torque wrench to continue to tighten the four mounting screws in a crisscross manner to approximately 64 in-oz (0.45 N-m).

   For example:

   a. Use a 3/32-inch hex wrench to tighten the corner screws, finger-tight only, in this order:
      – NW corner
      – SE corner
      – NE corner
      – SW corner

   b. Use a torque wrench set at 64 in-oz to repeat the procedure described in Step a.

The torque may vary from 30 to 90 in-oz, and from one installation to the next, but the torque should not vary by more than a few inch-ounces between the four screws.

The absolute value of torque is not as important as ensuring that all four corners are torqued equally. Use a single-valued torque wrench to eliminate variation associated with interpreting a flex beam needle, or setting a variable "click" torque wrench consistently. The torque wrench (PN 136-558) is available for torquing cores.

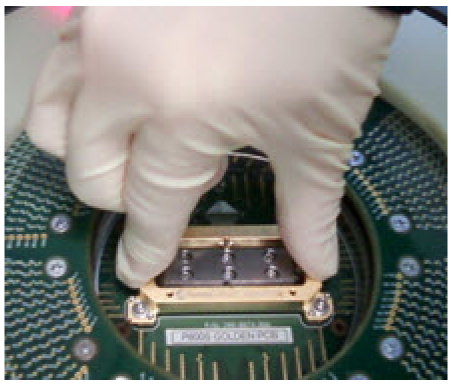
4. If your core is edge sense equipped, attach the edge sense connector to the two edge sense pins projecting from the north side of the metal core frame.

P800-S

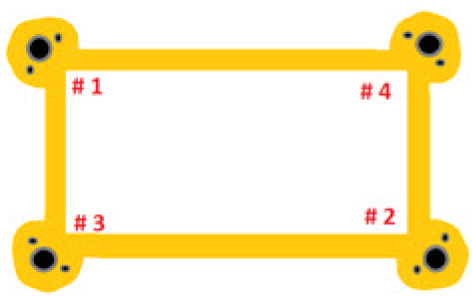
CAUTION

Ensure adequate clearance under the probe card. The probe tips may protrude from the bottom of the card more than 315 mils (8 mm), and may be unprotected during handling.

1. To orient the core, place it into the PCB, ensuring that the four alignment pins engage the alignment holes and the core sits flat on the card. The core is oriented correctly when the core frame key matches the silkscreen outline on the PCB. The key is generally located in the lower left corner.
2. Use your thumb and index finger to press down on the west and east quadrant of the frame until it is lying flat on the PCB.



3. While continuing to press down on the frame, use the 3/32-inch hex wrench to tighten the corner screws in an alternating corner-to-corner pattern as shown so that they are just snug to the washer/frame.



4. Use the 3/32-inch hex wrench to tighten the corner screws one quarter to one half of a turn. Use the tightening pattern described in Step 3.
5. Use a torque wrench set at 64 in-oz to torque the corner screws. Again, use the tightening pattern described in Step 3.

Inspect the Core Using a Microscope

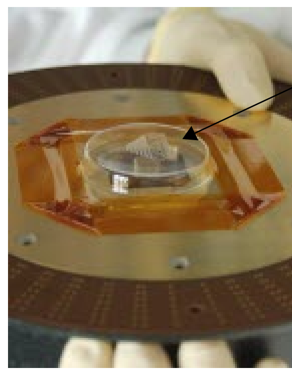
A more detailed visual inspection using a microscope verifies that the probe tips are clean and uniform in size and shape, the membrane is not damaged, and components are correctly mounted and undamaged.

CAUTION

Take special care not to contact the probe tips when adjusting the microscope. Be sure to maintain an adequate working distance (spacing) between the microscope lens and the probe tips.

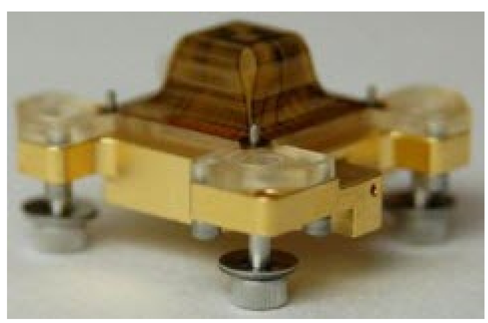
Prepare the PCB

1. Turn the probe card and mounted core assembly upside down.
2. Remove the protective cover (if installed) and place the assembly under the microscope for inspection.



Protective cover

If you are not using a probe card, microscope inspection is performed by placing the core frame upside down on the microscope stage with the probe tips facing up. The screws can be partially removed to support the frame.



Core upside down, with probe tips facing up

CAUTION

Components such as EEPROM or edge sense may protrude from the core frame and preventing it from laying flat for inspection.

Inspect the Core

Perform a general scan of the core probe with tips facing up (wafer side of probe card) under a standalone microscope.

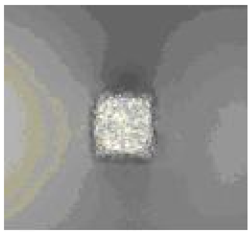
Verify the following:

- Probe tips are clean and uniform in size and shape
- Beams are free of cracks

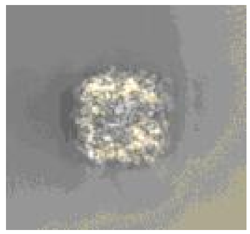
- Beam slope (excessive beam slope can result in an open)
- Membrane is undamaged
- Components are correctly mounted and undamaged

Inspect the Probe Tips

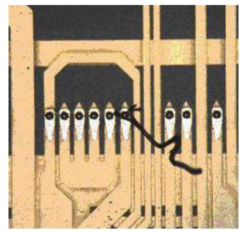
Ensure that probe tips are clean and free of any fibers, contaminants or particles.



Clean tip

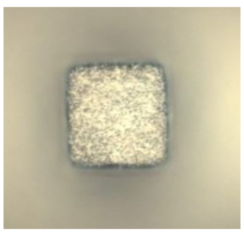


Organics on tip

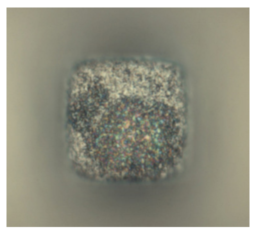


Fiber on tips

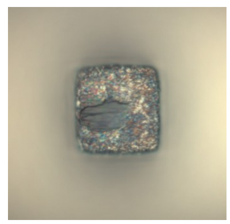
Fiber on tips



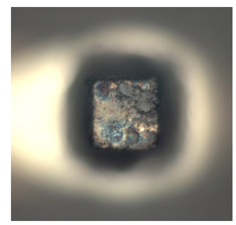
Clean tip



Organics on tip

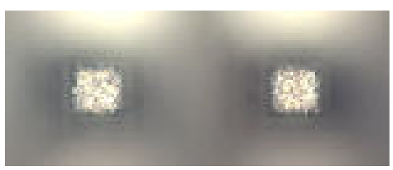


Solder on Tip

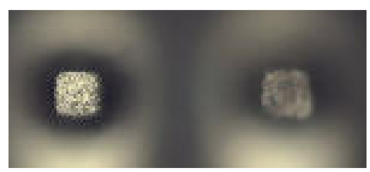


Solder on Tip

Probe tips should appear uniform in size and shape.
The probe tip height should be within 2 μm of adjacent tip height.



Clean, uniform, even height tips

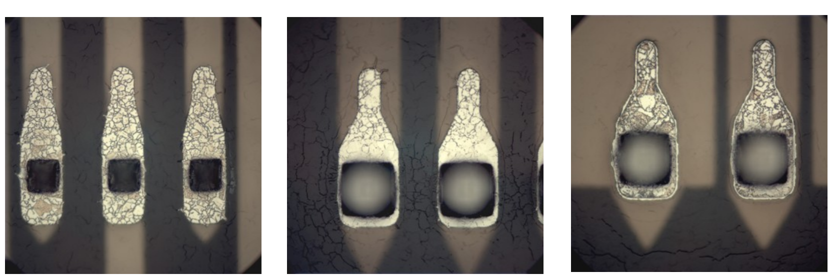


Uneven tips

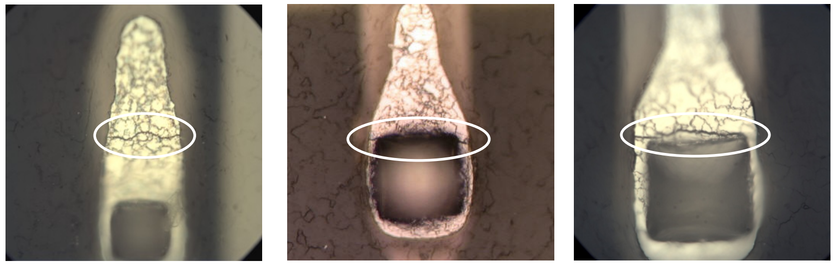
Inspect the Beams

Beams should be free of cracks. Be sure to check for fine cracks at the junction of the probe tip and the beam. Don't mistake the grain structure of the metal for cracks.

Good beams



Cracked beams



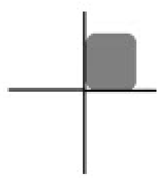
Measure Beam Slope, Probe Tip Diameter, and Probe Tip Height

Note

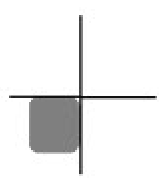
Beam slope occurs on probe tips when the membrane has become deformed over time due to overtravel forces. Too much beam slope reduces the effectiveness of MicroScrub and cleaning, leading to increased contact resistance and indicating the end of life.

For new probes, compare the probe tip diameter and height measurements to the pProbes Outgoing Report Tip Measurement Data.

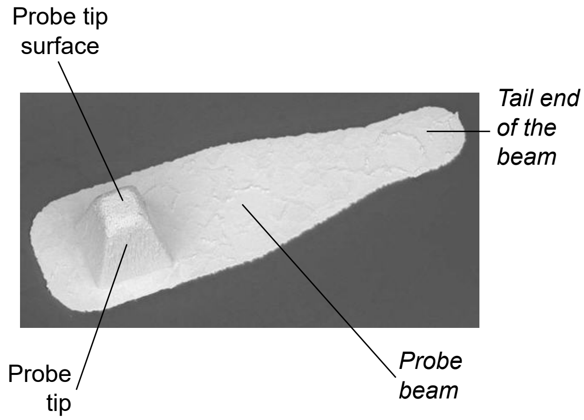
1. Place the item on the hi-mag microscope stage.
2. Focus on the beam, 10 µm away from the base of the probe tip.
3. Zero the z-readout or record the z-height.
4. Focus on the beam near the tail end, approximately 5-7 µm from the edge.
5. Measure and record the z-height in µm, it should be less than 5 µm for a new probe.
6. Repeat Step 2. and Step 3. to start the tip height measurement.
7. Focus on the probe tip surface.
8. Measure and record the z-height in µm.
9. Remain focused on the probe tip surface and align the microscope cross hairs to the lower left hand corner of the tip.

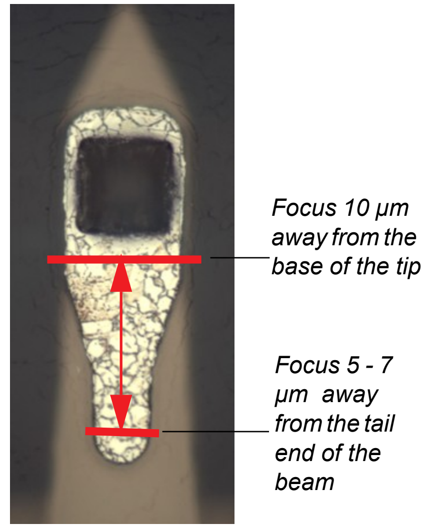


10. Zero the x/y readout.
11. Align the microscope cross hairs to the upper right hand core of the tip.



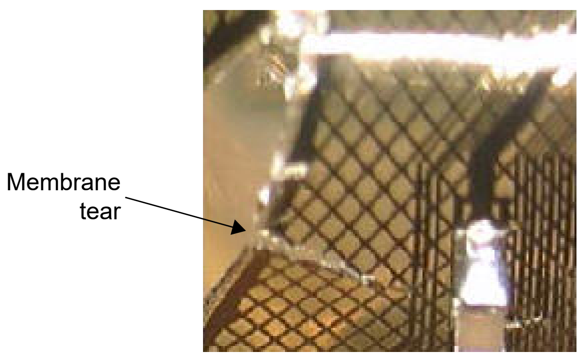
12. Measure and record the x and y diameters in µm. .





Inspect the Membrane

Look for any obvious tears in the membrane.



Inspect Components

Inspect components mounted on the membrane wings. Refer to the Membrane Layout drawing and verify that components are present at each location.

Verify that there are no cold solder joints or cracks in the solder present.

Uninstalling and Storing the Probe Core

Always follow these procedures when handling the cores:

- Wear gloves when handling cores and boards.
- Handle the core by its frame only.
- Do not set the core face (tips) down on any surface.
- Contact the edge sense pins only when connecting or disconnecting from the PCB.
- Do not bend the edge sense pins. Doing so can change the edge sense value.

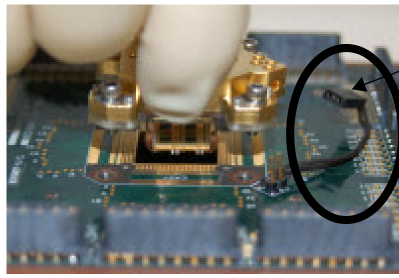
The following tools are required:

- Probe core box
- 3/32-inch hex wrench (or Allen wrench)

Removing the Core from the Probe Card

Standard (non-P800-S)

1. If the core is edge sense equipped, disconnect the edge sense connector from the two pins projecting from the north side of the metal core frame before removing the core from the probe card.

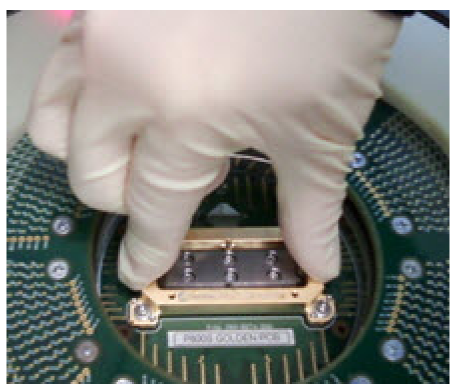


Disconnect Edge Sense before removing the core from the probe card

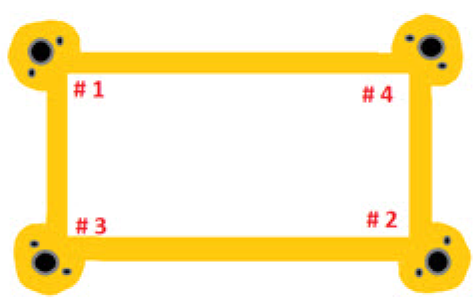
2. Use a 3/32-inch hex wrench to loosen the four mounting screws. Holding the core by the frame, carefully lift it vertically, making sure not to touch the core to the PCB or the membrane (wings) to the sides of the PCB opening.
3. Remove the core.

P800-S

1. Use your thumb and index finger to press down on the west and east quadrant of the frame.



2. Use the 3/32-inch hex wrench to slightly loosen the corner screws in an alternating corner-to-corner pattern as shown.



3. Completely loosen all corner screws using the pattern described in Step 2..
4. Remove the core.

Storing the Probe Core

When not installed on a probe card, cores should be stored securely in the core box for mechanical protection. As with all precision components, cores should be stored in sealed containers to keep out dust and contaminants, away from excessive heat.

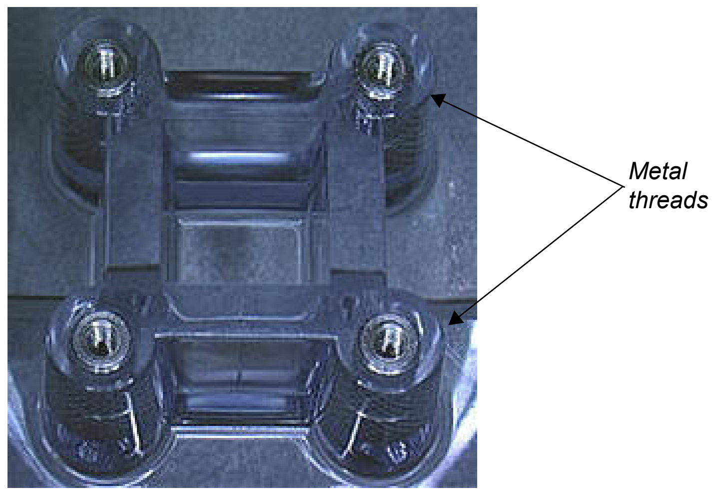
There are two types of core box:

- New core box
- Old core box

Different procedures are required to install the core into each type of box.

New Core Box

In the new core box, the probe core is secured with four screws that engage metal threads.



To install the core in the new core box:

1. Use the 3/32-inch hex wrench to tighten the four mounting screws, finger-tight only, in a crisscross manner.
2. Use a torque wrench to continue to tighten the four mounting screws in a crisscross manner to approximately 64 in-oz (0.45 N-m).

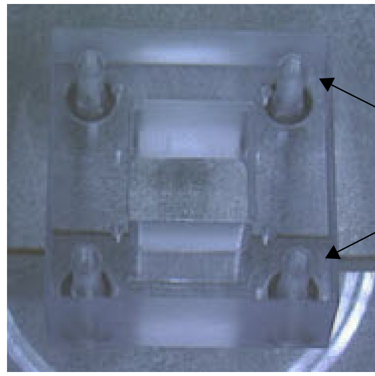
   For example:

   a. Use a 3/32-inch hex wrench to tighten the corner screws, finger-tight only, in this order:
      – NW corner
      – SE corner
      – NE corner
      – SW corner

   b. Use a torque wrench set at 64 in-oz to repeat the procedure described in step a.

Old Core Box

In the old core box, the core is secured with four screws that engage plastic threads.



To install the core in the old core box, the four mounting screws should be finger-tightened only, in a crisscross manner, to avoid stripping the plastic threads in the core box.

Core Specification Verification Process

Verifying core specification parameters on the probe card analyzer is an optional step, depending on whether your process includes checking specifications.

CAUTION

To avoid accidental damage to the core:

- *Do not use a raised pop-up or raised isolation pin or dot*
- *Be careful when using an acceptable pin or dot*
- *Set the correct overtravel*
- *Ensure all probe tips are supported by plate or chuck when in contact*
- *Do not allow any probe tips to hang off edge of plate or chuck*
- *Do not perform gram force test.*
- *Do not perform wire check test*
- *Never use lateral movement on probe tips*

Probe Card Analyzer Setup Specifications

CAUTION

Be careful when using the camera during alignment. To avoid damage to the adjacent probe tips, do not allow the check-plate to z drive up into a probe tip with the beveled glass lenses.

Parameter	Specification
Max overdrive/overtravel	See Certificate of Conformance on page 8. Maximum overtravel is measured from first touch.
X,Y alignment tolerances (as measured at FormFactor)	Product specification
Tip alignment	Performed at 50 µm overtravel past first touch (set 0 µm in some cases, including P800S)

Probe Card Analyzer Tests

Parameter	Specification
Electrical First Contact to Last Contact (FTL)	See Certificate of Conformance on page 8.
Resistance (measured on the analyzer checkplate only, not on the isolation dot)	< 7 Ω (or design-specific value)
Leakage current (typical values)	• Function test: - I/O lines: <7 nA - Component lines: add 1nA per component • DC parametric test: - I/O tips 7000 pA (<7 nA)
Component value measurement	For single, in line or decoupling component, resolution and accuracy is ~1% full scale plus 1% of measured value.
Capacitance	Range 1 nF to 10,000 µF
Resistance	Range 1 Ω to 100 M Ω
Leakage	30 pA to 1000 µA

Network components are measured as a unit on the PB3500/PB3600 system and verified with hand probing on first articles. Test values are fixed and subsequent cores are compared to first article values.

The probe card analyzer can also be used to test the core for:

- Opens and shorts
- Alignment

Inductors are not measured on the PB3500/PB3600 systems.

Chapter

4 Operating

Operational Overview of Pyramid Probes

CAUTION

Safety warnings and precautions must be followed to ensure proper core performance and personal safety. FormFactor recommends wearing gloves when handling cores.

When not installed on a probe card, cores should be stored securely in the core box for mechanical protection. Refer to Storing the Probe Core on page 24 for details on installing the core in the core box.

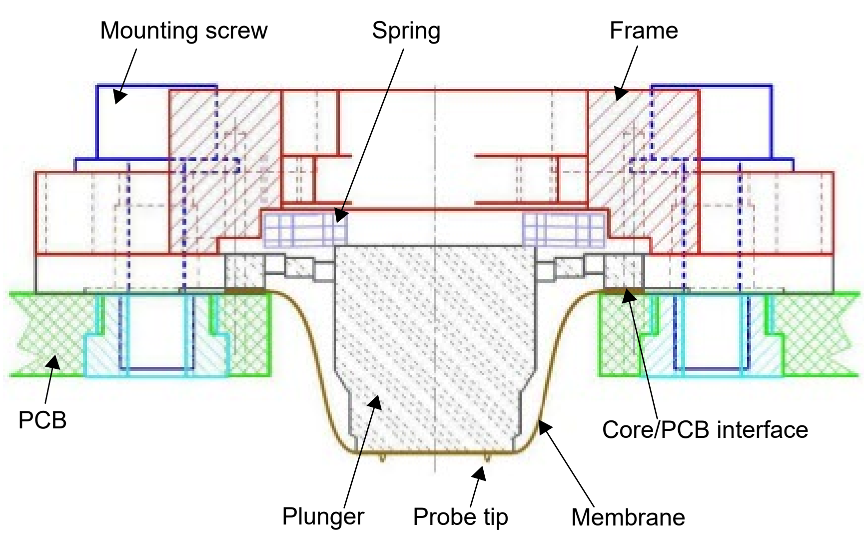
Membrane Technology

Pyramid Probes enable probing of the smallest pads through the use of the smallest probe tip available in the industry today. In addition, FormFactor's innovative MicroScrub technology features low particle generation.

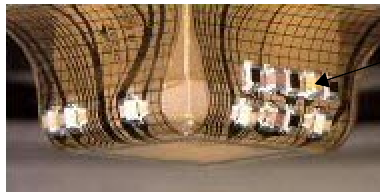
Pyramid Probes use thin film polyimide membrane to route controlled impedance lines and place bypass capacitors close to the DUT, providing excellent electrical performance. Each membrane is customized to the individual DUT. Extremely low ground and power inductances are possible. The low maintenance probe tips remain in the same location over the life of the probe, improving test cell uptime and reducing the cost of ownership in comparison to other technologies.

The die contact area is adhered to the plunger assembly with a compliant adhesive layer. The membrane is routed through a hole in the probe card, and the signals connect to the tester side of the PCB, eliminating the need for a via through the PCB in the critical signal lines.

Cross-section of Pyramid Probe mounted to PCB



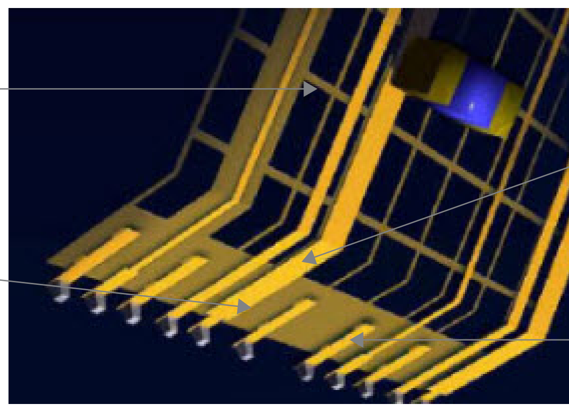
Transmission lines in the membrane decrease signal loss. The membrane design allows components such as bypass capacitors to be placed closer to the DUT.



The basic line types in the membrane consist of:

- RF – for controlled impedance transmission lines
- AC – for low speed signals
- DC – for digital control or non-critical bias connections
- P – for power supplies
- GND – for connection to the ground plane.

Thin-film model



Line Type Characteristics

Table 5. Typical characteristics of line types used in the core membrane.

Line Type	Impedance	Design Rules	Max. current	Geometry
RF	50 Ω	Controlled impedance	300 mA	40 µm wide over solid ground
AC	50-70 Ω	Route random over mesh	600 mA	80 µm wide over mesh
DC	Uncontrolled	No design rules	600 mA	80 µm wide over mesh
Power		No restrictions	1,000 mA	200-250 µm
GND		No restrictions		Plane (mesh)

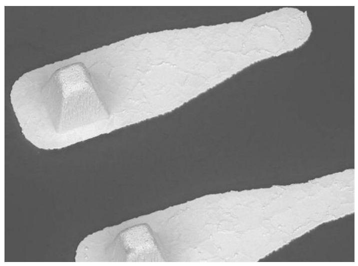
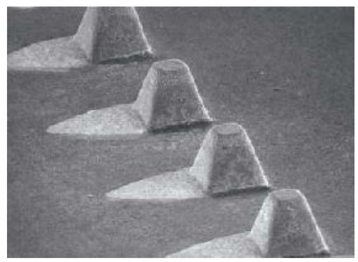
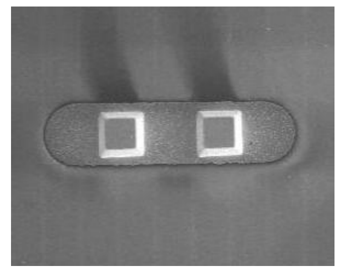
Any combination of RF, DC, power and ground-pad layouts can be probed, as the membrane layout is specifically designed to fit the pad geometry of each device.

Probe Tips

Understanding the size and shape of structures on Pyramid Probe cores is crucial to minimizing contact resistance and pad damage. Probe tips are made from a proprietary, non-oxidizing nickel alloy and are differentiated by the type and arrangement of metals they probe.

Due to the membrane-based construction, probe tip positional accuracy is stable over the lifetime of the core, on the order of ±10 µm .

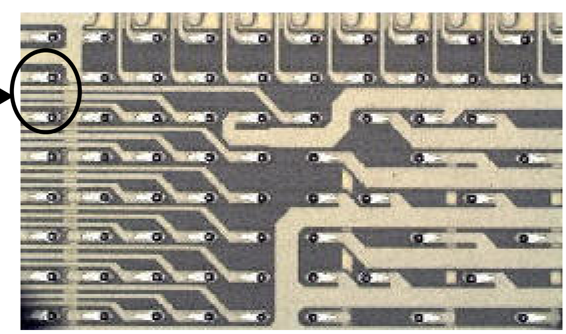
Probe Tip Types

Pyramid Probe tips for aluminum pads	Pyramid Probe tips for solder balls or gold pads	Interface between Pyramid Probe cores and the probe card
		

- Pyramid Probe tips for aluminum pads feature a 12 µm x 12 µm contact area and are 20 - 60 µm in height, depending on pad pitch. They are textured to provide MicroScrub action through aluminum oxides and other impurities.
- The top surfaces of Pyramid Probe tips for solder balls feature a 25 µm x 25 µm contact area, and are 20-40 µm in height, depending on pad pitch.
- In pad applications with fragile low-K dielectric, pad of active area (POAA), or circuit under pad (CUP) a 18 µm x 18 µm tip is used.
- The probe tips at the interface between the Pyramid Probe cores and the probe card boards feature a 40 µm x 40 µm contact area, and are and are 25 µm in height.

The minimum pitch between peripheral tips is 50 µm. For larger pitch arrays, it is possible to route traces between tips.

Traces routed between tips on a BGA (Ball Grid Array) probe tip layout



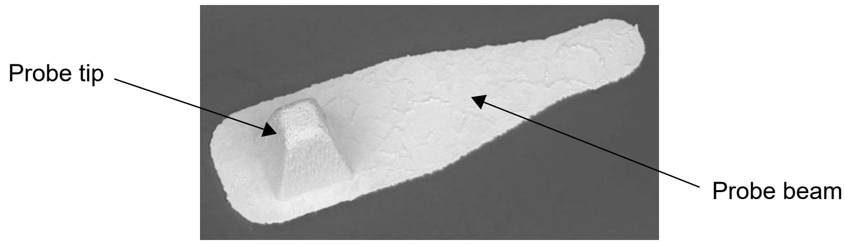
Probe Depth and Tip Height

Probe depth is the distance the probe tips protrude from the tester side of the probe card. Be careful when handling and installing the probe card because the probe depth can be 315 mils (8 mm) or more, depending on the design.

Probe tip height is the height of the probe tips, in µm, from the membrane probe face.

Membrane Mechanics

Pyramid Probes have an advantage in mechanical stability over cantilever probes in the xy plane. Probe tips are photolithographically positioned on the membrane, which acts as a common base, resulting in more positional accuracy than cantilever probes and allowing the tips to retain a single position over the life of the probe. These probe tip structures are called beams.

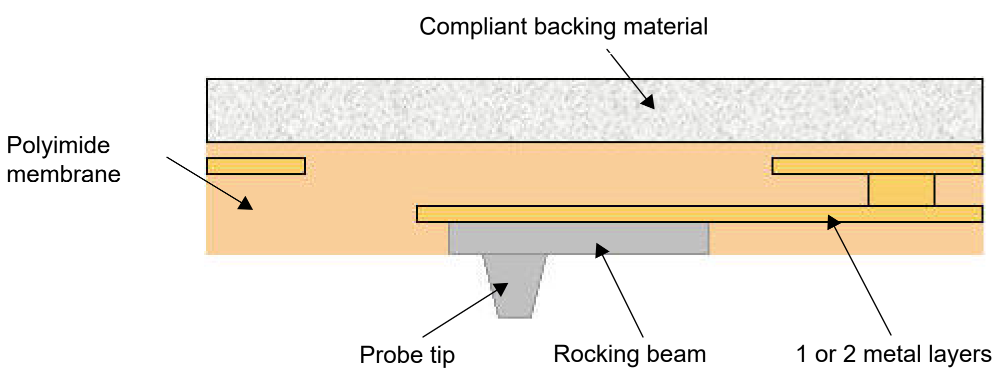


Cantilever probe needles act like independent springs. Errors in the xy position of a probe tip can cause poor contact between the needle and the pad or bump surface, or cause the needle to miss the pad or bump entirely.

Variations in the z-axis position of the probe tip can require large amounts of overtravel to ensure good contact. Extreme overtravel, however, can result in an excessive scrubbing motion which can damage probe targets, or even cause the probe tips to skate off the wafer surface.

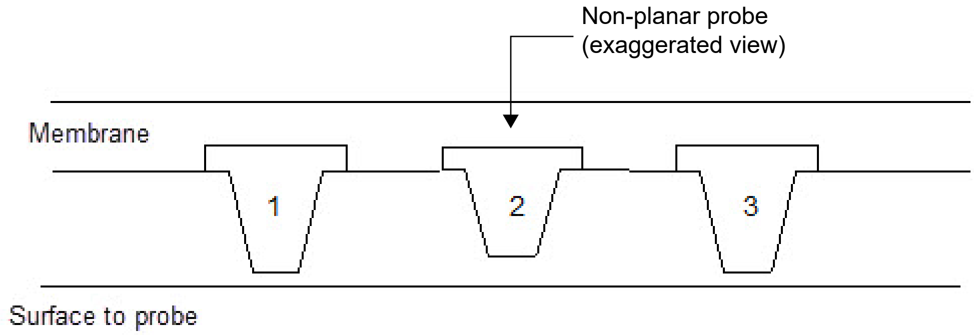
Positional Accuracy

The positional accuracy of Pyramid Probe tips results from tip placement, based on the layout of the customer's DUT. The tips are etched onto a thin film membrane using a photolithographic manufacturing process, and the base of each Pyramid Probe tip is embedded in the dielectric thin film.



Once designed, Pyramid Probe tips maintain xy positional accuracy over the life of the probe. The scrub motion with Pyramid Probes is limited to 5 µm in the xy plane, ensuring that probe tips don't skate off their target pads. Such positional stability extends the probe's service life and ensures reliable probe-to-pad alignment, especially for fine-pitch DUTs.

Because the probe tips are located on a common base, special treatment can be required in cases where the probed pads or probe tips are non-planar. When probes are non-planar, overtravel is required to enable all probe tips to make contact.



However, in such cases, the amount of overtravel required is much greater than the difference in height between adjacent pads because most of the overtravel is absorbed by the core springs and plunger. A much smaller amount of overtravel is absorbed by the compliant adhesive layer between the membrane and the plunger.

As pad pitches get tighter, the planarity of adjacent probe tips or probe surfaces has a greater effect on the electrical contact of each probe tip. This effect is known as mechanical coupling. Paying careful attention to height variation in probe tips and probe surfaces can minimize the effect of coupling.

Recommended Overtravel and Contact Force

Overtravel is measured relative to the first electrical probe tip contact. For Pyramid Probes with a plastic plunger, the target is 10 grams of force at 6 mils (150 µm) overtravel, or 1.67 g/mil per probe tip. For Pyramid Probes with a steel plunger
(P800-S), the target is 20 grams of force at 6 mils (150 µm) overtravel, or 3.33 g/mil per probe tip.

Pyramid Probe technology requires an equal application of force across all probe tips. For this reason, the use of single-point checkers for gram force is strongly discouraged.

FTL overtravel measurements vary with core tightening process. It has been shown that the use of a torque driver resulted in seven times more repeatable and 25 percent smaller FTL. It is therefore recommended that all core mounting screws be tightened with a torque wrench to remove FTL variation using a repeatable process. *See* Install the Core in the Probe Card on page 17 for more details.

Probe Planarity

The practical measure of planarity is the distance between the first and last electrical contacts.

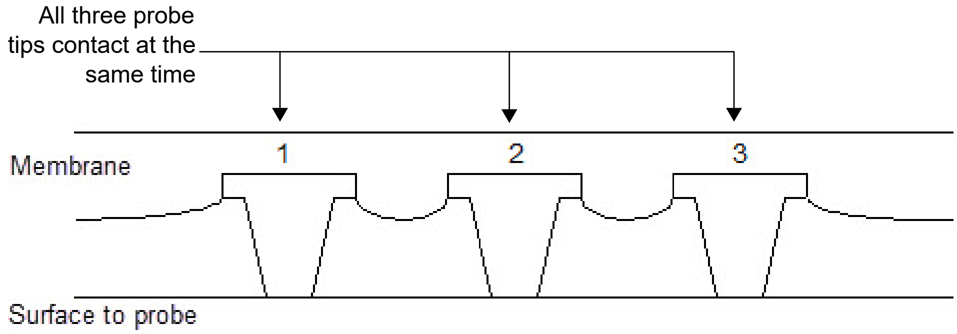
Several contributing factors determine planarity:

1. Probe tip planarity – *see* Probe Tip Planarity on page 32.
2. Bulk planarity – *see* Bulk Planarity on page 33.
3. Board planarity – *see* Board Planarity on page 33.
4. Probe card holder planarity – *see* Probe Card Holder Planarity on page 34
5. Device planarity – *see* Device Planarity on page 34.

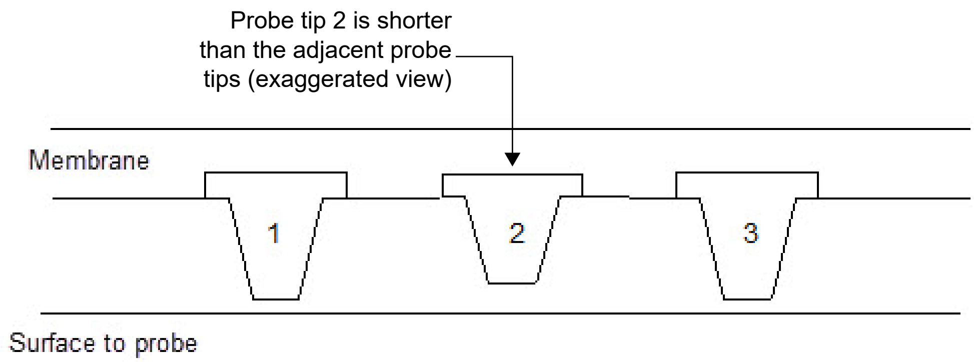
A discussion of each factor and its possible effect on FTL follows.

Probe Tip Planarity

Ideally, all probe tips should contact the DUT at the same time. Probe tip planarity issues occur when probe tips are not all in the same plane.



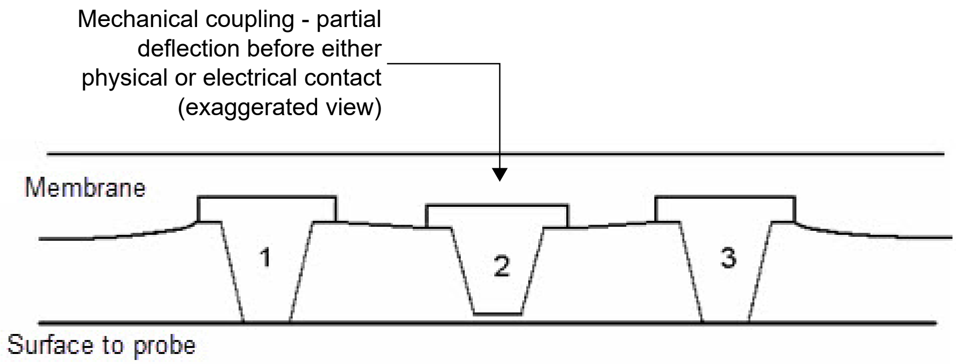
FormFactor's manufacturing process for Pyramid Probes results in slight variations in probe tip height. The magnitude of this difference is generally under 1µm.



If the probe tips were not connected by a membrane, the contribution to FTL would be the difference between the height of tip 2 and tips 1 and 3.

However, the connecting membrane will cause tip 2 to move as tips 1 and 3 are deflected by contact with the wafer surface.

As the deflection continues, tip 2 will get closer to the surface until it makes physical, and then electrical contact.



Mechanical coupling can cause up to a 20 to 1 increase in FTL, compared to the difference in the probe tips. For a 1µm tip height difference, an increase of approximately 20µm in FTL results.

CAUTION

Particle damage is one of the largest causes of failure for Pyramid Probes.

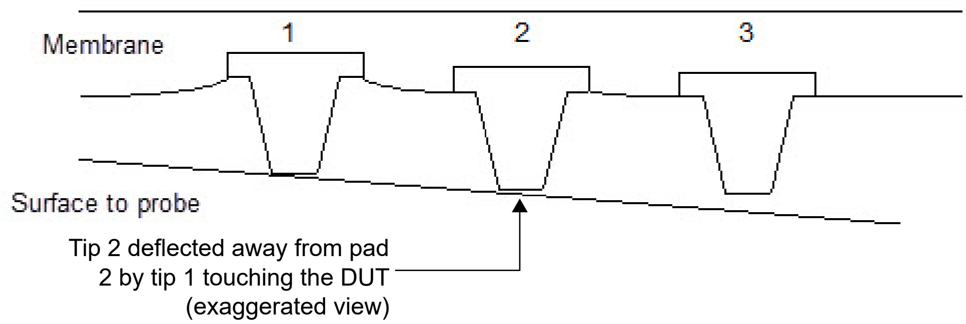
The tip height difference can also be the result of damage from the tip hitting a particle on either the wafer surface or the area where the tips are cleaned.

Bulk Planarity

Bulk planarity issues occur when the plane defined by the probe tips is not parallel to the plane defined by the wafer surface. The core's bulk planarity can be adjusted at FormFactor's factory or service centers.

As the first probe tip contacts the wafer surface, it deflects the membrane, causing the adjacent probe tip to move farther away. The effect of bulk planarity is multiplied by mechanical coupling.

In the following illustration, overtravel is such that tip 2 is unable to make contact due to the contact with tip 1. The membrane has lifted tip 2, resulting in an increase approximately 20 times the measured FTL over the strictly mathematical calculation of addition due to the slope difference.



Board Planarity

Board planarity issues occur when the plane defined by the top surface of the board is not parallel to the plane of the wafer surface.

The Pyramid Probe core is attached to the tester side of the probe card with four screws that push the core contacts onto the board contacts and hold the core in place. This core mounting area and the surfaces around the threaded inserts define the plane on the top surface of the board.

Board planarity is a measurement of the planarity of the wafer surface and the core-to-board interface area.

The flatness of the board, as measured by the PCB manufacturer, is not the same as the flatness required for a Pyramid Probe. Consider the following:

- The core mounting area may be flat but the PCB is structurally not flat. “Not flat” means that the board surface does not form a plane, yet is still flat as defined by the core mounting area.
- The board surface may be curved, yet still considered flat because the core mounting area is coplanar with the wafer surface.
- The board surface may define a plane parallel to the wafer surface, yet the core-to-board interface plane is not parallel to the wafer surface.

While a PCB may be perfectly flat, the structures in the core-to-board interface area may cause a lack of planarity with the wafer surface.

Avoid the following conditions, which will raise a corner of the core and move the probe tips out of planarity with the DUT:

- Improper installation of the threaded inserts (PEM® nuts) to extend more than 8 mils above the PCB surface
- Burrs in the threaded insert holes protruding above the surface of the board
- Encroachment of the solder mask in the mounting keep-out area
- Improper installation of the core in the PCB (unequal screw torque)
- Any vias or traces in the mounting keep-out area
- Damage to the PCB when inserting PEM mounting nuts

On PCBs that have stiffeners, flatness correction is performed by putting non-metallic shims between the board and the stiffener to adjust the planarity of the core mounting area.

Probe Card Holder Planarity

Probe card holder planarity issues occur when the plane defined by the surface supporting the probe card is not parallel to the plane of the wafer surface.

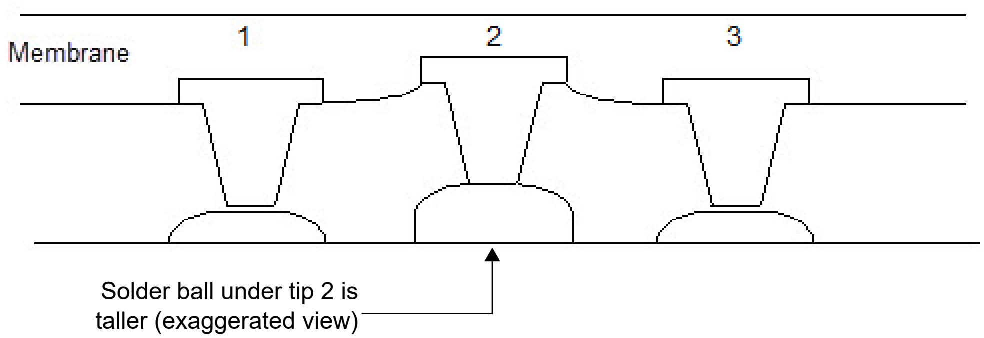
The surface supporting the probe card is sometimes referred to as the head plate, platen, probe card holder or probe card plate.

Normal prober preventive maintenance (PM) can detect and adjust the planarity of the surface supporting the PCB. It is important to keep the prober in good condition.

Device Planarity

Device planarity issues occur when the points to be probed are not all in the same plane.

This condition occurs most commonly when probing solder balls. In the following illustration, the solder ball under tip 2 is taller, causing it to make contact first. The connection between tip 2, and tips 1 and 3 causes an increase in FTL that is greater than the difference in the height of the solder bumps.

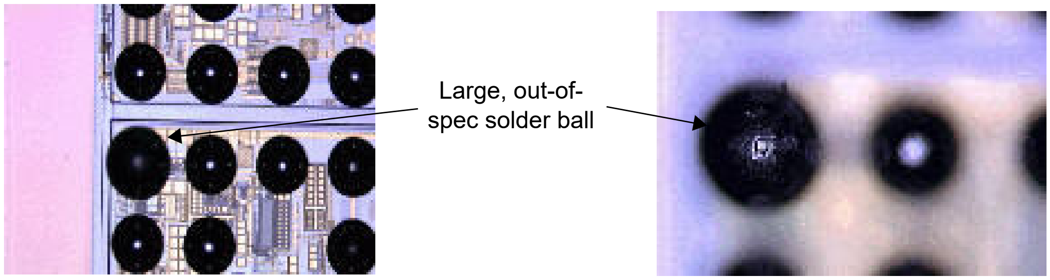


If the height difference is too large or if a tall particle is present, the core can incur permanent damage. Because the elastic limit of the tip structure is exceeded, the tip will not return to its original z-height. If the damage is minimal, an increase in overtravel may be required to continue.

Contact your Field Applications Engineer for further assistance.

Height Thresholds

The height threshold for opens is 15µm to 25µm (likely on adjacent die also), while the height threshold for probe damage is 25µm to 50µm. Solder balls with heights over 100 µm higher than neighboring balls can cause significant probe damage.



When probing solder balls that are expected to have significant height differences, use a pre-screener to detect die with these anomalies *before* probing.

MicroScrub Technology

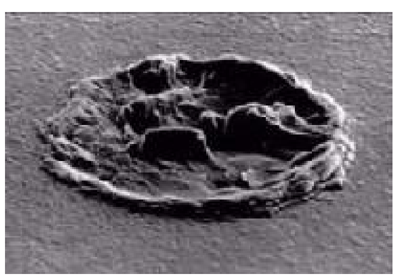
The Pyramid Probe's membrane-based design provides a micro-scrubbing action which results in smaller scrub marks and reduced pad damage on the DUT. The patented MicroScrub action of Pyramid Probes penetrates metal oxides and cleans the probe tips with each contact.

While resistive buildup contaminants can accumulate on the probe tips during probing, Pyramid Probe tips do not typically experience as much resistive contaminant buildup as other probe technologies. *See* Membrane Mechanics on page 30 for a description of the problems caused by overtravel and excessive scrubbing.

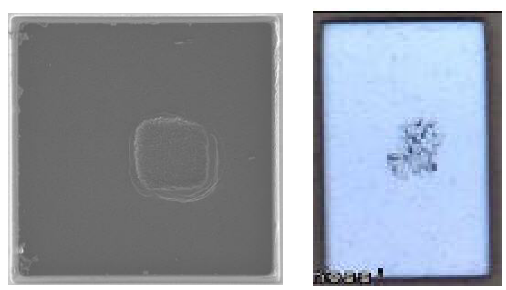
Characteristics of the Pyramid Probe MicroScrub include:

- Typical scrub length of 3 µm
- Positional accuracy within ±10 µm

Typical Pyramid Probe scrub marks



3 µm scrub close-up



Scrub mark on pads

Accuracy and Repeatability

As described in Membrane Mechanics on page 30, Pyramid Probes have an advantage in mechanical stability over cantilever probes. Some of the operational differences between Pyramid Probes and cantilever needle probes include:

- Fixed probe tip planarity in x, y and z-axes pin-to-pin due to photolithographic manufacturing process
- No need for periodic positional probe tip adjustment
- Positional probe tip accuracy better than ±10 μm
- Consistent probe tip alignment under multiple touch downs
- More probe overtravel required, typically 150 μm vs. 50 μm
- Easy probing of complex pad arrays

Production Test Operation

Handling the Core

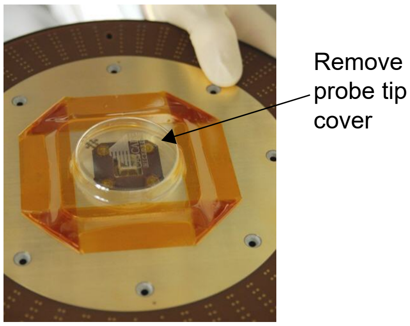
Because Pyramid Probes are precision devices, cores and cards must be handled, installed and maintained carefully.

Before handling your core, read the directions carefully. *See* Install the Core in the Probe Card on page 17 and Removing the Core from the Probe Card on page 23 for more information.

Follow all safety warnings and precautions to ensure proper core performance and personal safety. FormFactor recommends wearing gloves when handling cores.

When not installed on a probe card, cores should be stored securely in the core box for mechanical protection. Refer to Storing the Probe Core on page 24 for details on installing the core in the core box.

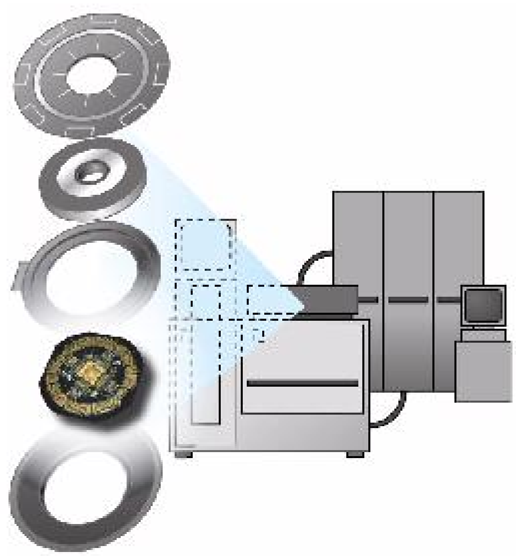
Be sure to remove the probe cover before installing the probe card.

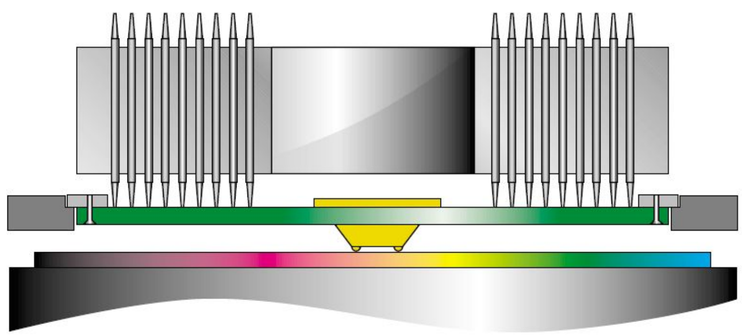


Setting up the Autoprober

Interface Module

The probe card is mounted to the tester interface and mated to the POGO® ring via the POGO pin spring contacts.





Specifications

Each Pyramid Probe ships with an Certificate of Conformance *(see* Certificate of Conformance on page 8) which contains the specifications for planarity, recommended overtravel and edge sense for your Pyramid Probe.

These values are unique to each individual Pyramid Probe. The serial number of the specific Pyramid Probe is shown on the Certificate of Conformance.

NOTE

None of these specifications are additive. They all have the same zero, which is first electrical contact.

Recommended Overtravel	The recommended overtravel from electrical first contact. Certificate of Conformance on page 8 NOTE: Do not exceed the maximum overtravel identified in the Certificate of Conformance. Please consult your Field Applications Engineer before exceeding this upper limit.

Edge sense	The amount of overtravel from first electrical contact until the normally closed edge sense switch opens. When using the edge sense switch, subtract this number from the recommended overtravel to calculate distance, after the edge sense opens, to recommended overtravel.
Electrical FTL	The amount of overtravel required to make electrical contact with all the probe tips in a fixture at the factory. This amount may vary from one test setup to another.
Planarization	No planarization is required, as long as the probe card holder has been set to a nominally planar condition. NOTE: There is no field adjustment to planarity of the membrane to the PCB.
Troubleshooting	Poor electrical performance is more likely due to contamination rather than planarity issues. This is especially true if the performance improves with increased overtravel. *See Troubleshooting on page 49* for diagnostic procedures.

Probing

Probe depth is the distance from the probe tips to the wafer side of the PCB (the amount the core protrudes from the board), measured in mils or millimeters.

Probe tip height is the distance from the probe membrane to the probe tips, measured in µm.

CAUTION

- ***Stepping:*** *Never traverse the chuck when it is in contact with the Pyramid Probe.*
- ***Scrub:*** *Do not use any kind of scrub when cleaning against an abrasive surface. Use only z-motion.*
- ***Hot Probing:*** *Do not 'hot probe'. Turn off power supplies before lifting or touching down with the probe. Inductive cables and capacitors can store significant energy that can damage probe tips and/or signal lines. Hot probing can result in spikes of several amperes even when power supplies are current-limited, since the outputs are typically very capacitive and discharge when making contact with the DUT.*
- ***Off Stepping:*** *Do not step off the wafer.The wafer map should be adjusted so that the Pyramid Probe does not contact incomplete or partially-processed edge die, or step off the wafer.*

Core and Board Planarity

The Pyramid Probe core is attached to the tester side of the probe card with four screws that push the core contacts onto the board contacts and hold the core in place. This core mounting area and the surfaces around the threaded inserts define the plane on the top surface of the board.

Electrical contact is the most safe and accurate way to measure planarity and avoid damage to the probe card. Check different lines on all sides of the probe to verify planarity. If it does not meet your specification, check the planarity of the probe card holder to verify that it is not the source of the planarity problem.

Although a probe mark inspection to check for planarity is less precise, and more prone to subjective judgment and lighting effects than an electrical check, it is a good gross check to ensure the planarity of the probe after the probe card has been set up and first contact has been determined electrically.

NOTE

Probe planarity is measured and adjusted at the factory using a probe card analyzer. Using probe marks to verify planarity may not correlate to the planarity measured on the analyzer.

For further information, *see* Probe Planarity on page 31.

Contaminants

Contaminants on Pyramid Probes can be divided into two general classes:

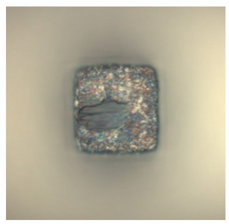
- Particulate contaminants
- Resistive buildup contaminants

See Contaminants on page 44 for recommendations on best practices, and Cleaning Contaminants on Pyramid Probe Cores on page 47 for more information about removing contaminants from your core.

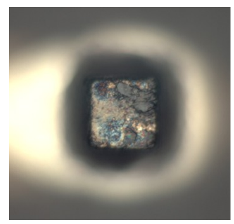
Special Considerations for Solder Probing

Height differences are common when probing solder balls. If the height difference is too large or if a tall particle is present, the core can incur permanent damage. *See* Device Planarity on page 34 for further details.

Pyramid Probe tips used for solder ball probing are much more susceptible to accumulation of resistive buildup contaminants.



Solder on Tip



Solder on Tip

See Solder Probing Contaminants on page 48 for information about removing contaminants related to solder ball probing.

Thermal Performance

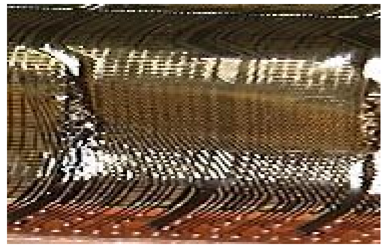
Thermal performance issues are commonly due to:

- Overcurrent (*see* Excessive Current (Overcurrent) on page 39)
- Probing temperature (*see* Probing Temperature on page 40)

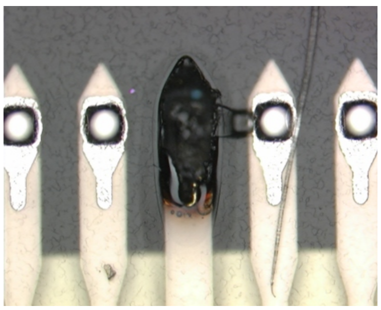
Excessive Current (Overcurrent)

The current rating for individual probe tips is 200 mA. Exceeding this rating may cause damage to the core membrane. ATE power supplies should have the current limit set to the specifications for the DUT, but not to exceed the rating of the probe tip. Power supplies must have fast current clamping. Test programs must ensure that these limits are not reset to higher defaults during the program execution.

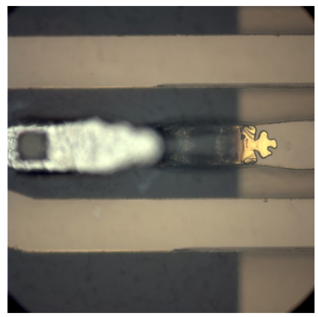
The core membrane can become severely damaged or destroyed by heat from power dissipation caused by excessive current. Excessive current includes both short-duration current spikes and longer-term operation exceeding the current rating of the probe tip. The probe tips may burn up or the tip beams may become pressed into the membrane, causing a loss of planarity. In extreme cases, membrane traces can be burned up.



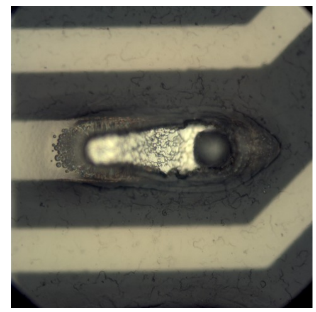
Thermal damage – trace burned up



Beam and tip burned up



Heat damage



High current damage

If more current capacity is required, probe tips can be bussed in parallel to a common supply or to ground when specifying the probe membrane design.

Probing Temperature

Maximum operating temperature for the Pyramid Probe core is 125°C. The probe card will deflect in the z-axis with increased temperature. It is important to set the z-axis zero point at the operating temperature, rather than at ambient or an alternate temperature.

The wafer and the core membrane have different coefficients of thermal expansion (C_{TE}). This difference will change the position of the probe tips with respect to the pads as the operating temperature changes.

If probing at more than one temperature, first soak the probe at the new operating temperature to allow it to thermally stabilize. Then set the contact height and realign before resuming probing. Soak time is determined by the user.

Chapter

5 Best Practices with Pyramid Probes

This chapter provides best practice the recommendations for using and maintaining Pyramid Probe cores. Following the these recommendations will ensure long term success with your Pyramid Probe core.

Alignment

Probe Card Analyzer Alignment

WARNING

DO NOT test the P800-S (steel plunger) cores on any probe card analyzer.

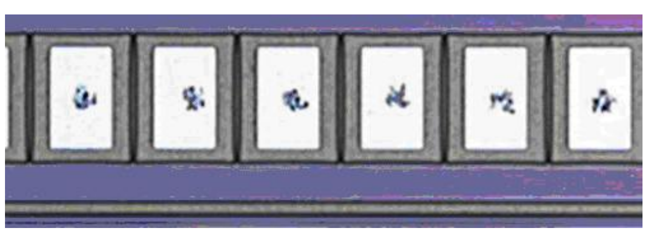
Pyramid Probe cards can be tested with a probe card analyzer, with the following considerations.

- Bulk planarity can be checked using the chuck or plate.
- Bussed-pin planarity can only be tested when using an isolation pin that is flush with the plate or chuck.
- Never step off the chuck or plate. Probe tips may hang off the chuck or plate during alignment, resulting in damage to the probe.
- To avoid damage to the core, the chuck or plate must be planar to the probe card and clean of any particles.

Automatic Probe-To-Pad Alignment

Most modern autoprobers feature automatic probe-to-pad alignment. While look-down cameras allow the repeatable alignment of wafers, look-up cameras find and focus on the probe tips.

By combining this information, the prober is able to align the pads and probe tips for accurate probe-to-pad alignment. Probe-to-pad alignment allows for one-button setups after training the prober to the wafer and probe card locations.



Typical probe alignment

Pyramid Probe cores, due to their membrane-based fabrication, have inherent probe tip positional accuracy on the order of ±10 µm. Probe-to-pad alignment on Pyramid Probe cards usually requires an algorithm that differs from needle cards, due to the membrane surface. Collaborate with your prober supplier to identify the best algorithm and parameters.

FormFactor Applications Engineers have had success using the TMPC2 algorithm on TEL probers. The prober is taught the location of fiducial marks, which are easier to locate than the probe tips. Next, the prober is taught the location of the probe tips, which it uses to calculate the offset from the fiducials. This calculation enables the prober to use the fiducial marks for alignment, rather than the probe tips. Fiducial mark algorithms are also available from other prober manufacturers.

FormFactor Applications Engineers have had success using both versions of algorithm #17 on Accretech probers. The newer version of this algorithm finds the probe beams, which are larger and easier to recognize than the probe tips. Using the beam as a reference point, the prober then searches for the probe tips.

Overtravel

Limiting Overtravel

While Pyramid Probe cards generally use greater amounts of overtravel than other probing technologies, excessive overtravel should be avoided.

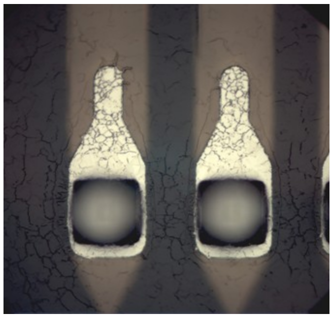
The need for excessive overtravel indicates a problem. Probing systems that require excessive overtravel may have non-planar chucks and headplates, or contaminated pads or probe tips.

Do not exceed the maximum overtravel identified in the Certificate of Conformance on page 8. Please consult your Field Applications Engineer before exceeding this upper limit.

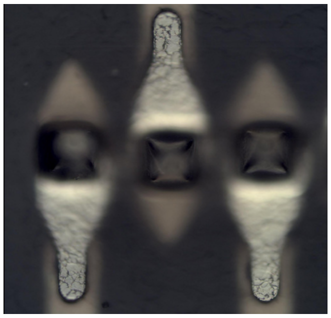
Avoiding Beam Slope

Excessive overtravel can cause a condition called beam slope, where the beam on which the probe tip sits develops a permanent tilt. Beam slope can be measured using a high mag microscope with a scaled z-axis.

Sloped beams will be out of the focal plane. Beam slope decreases the scrub action of a probe tip and can lead to premature failure.



Normal beams



Beams after excessive overtravel

See Measure Beam Slope, Probe Tip Diameter, and Probe Tip Height on page 21 or beam slope measurement technique.

Probing

Lateral Scrub

Lateral movement will damage the probe tips and should never occur when the probe tips are in contact with any surface. This is true for cleaning or any other application. Do not use “polish” type cleaning that is common with other probe card technologies.

Double Touch

Most modern auto probers include a feature called double touch, which enables two touchdowns in the same location before the electrical test is initiated. Double touchdown can be useful for some applications that require oxidation removal and contact resistance variation reduction. It is up to the end user to study the application of the Pyramid Probe card to determine whether double touch is effective in increasing test result reliability.

Hot Probing

CAUTION

Do not ‘hot probe’.

FormFactor strongly recommends lifting or touching down with the probe only while power supplies are turned off. Note that inductive cables and capacitors can store significant energy and damage probe tips and/or signal lines if this energy is not dissipated before contact.

Hot probing can result in spikes of several amperes even when power supplies are current-limited, since the outputs are typically very capacitive and discharge when making contact with the DUT.

Clearance

Ensure adequate clearance under the probe card. Probe tips may protrude from the bottom of the card more than 315 mils (8 mm) and may be unprotected when the card is handled. Be sure to remove the protective cover (if installed) from the wafer side of the PCB before installing it in the prober.

Stepping Off the Wafer

CAUTION

Never allow a Pyramid Probe to step off the edge of a wafer, a cleaning block, or any other surface.

Stepping off wafer will result in damage. Because all of the probe tips push on a single spring stack behind the plunger, the probe tips that are still in contact with the wafer will experience a higher than expected force. Stepping on partially processed die should also be avoided, as the contact material may be questionable.

Planarity

To avoid planarity problems, perform regular prober preventive maintenance and planarize the prober before probing.

See Board Planarity on page 33 for more information on FTL, board structural flatness and flatness of contact area.

Power (Current) Considerations

The core membrane can become seriously damaged by heat from power dissipation caused by excessive current. In some cases, heating can cause the beams to press into the membrane, causing a loss of planarity. In extreme cases, traces or probe tips can burned and destroyed.

To avoid damage to the core membrane:

- Set power supply current clamping based on DUT power needs, but do not exceed the maximum current rating for individual probe tips of 200 mA.
- Ensure that current clamp settings are maintained throughout the test program.
- Test for shorts before applying power.

Temperature Considerations

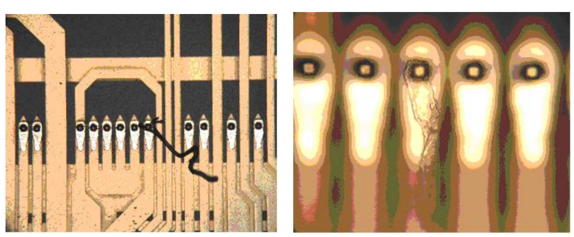
Follow these guidelines when probing at multiple temperatures:.

- Do not exceed maximum operating temperature of 125°C for the Pyramid Probe core.
- Set the z-axis zero point at the operating temperature, rather than ambient or an alternate temperature.
- Soak the probe at the new operating temperature to allow it to thermally stabilize when probing at more than one temperature.
- Set the contact height and re-align before resuming probing after temperature soak.

Contaminants

Particulate Contamination

Particulate contamination can cause catastrophic probe card failure. The best solution for particulate contamination is removal of the particles at their source.



Examples of fiber contaminants on tips

A few simple precautions can protect Pyramid Probes from particulate damage. To avoid accidental damage to the probe core:

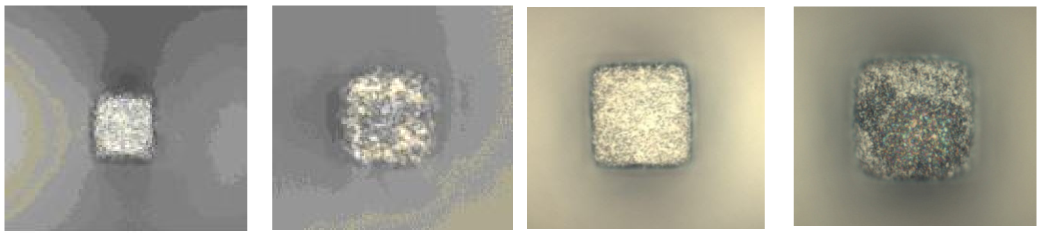
- Wipe down or vacuum particles from the prober before probing.
- Probe in a cleanroom environment.
- Wash wafers immediately before probing (especially after laser-scribe operations).
- Use extreme caution when probing correlation wafers.
- Do not load or unload probe cards with the wafer on the chuck.
- Do not share brushes between Pyramid Probes and other probe card technologies.
- Do not probe wafers that have been questionably stored.
- Do not touch the membrane, even with gloved hands.

See Particulate Contaminants on page 47 for more information.

Resistive Contamination

Organic contaminants and oxides can accumulate on the probe tips, creating resistive buildup. When buildup occurs, it typically appears as a dark discoloration on the probe tip surface.

Probe tip buildup



Clean tip — Organics on tip — Clean tip — Organics on tip

To maintain high yield, contaminants must be removed by abrasive cleaning. For best results, contamination should be removed preventively, using the wafer prober for online cleaning. Ensure that the online cleaning material is not worn or contaminated.

See Resistive Buildup Contaminants on page 47 for more information.

Cleaning

For detailed instructions on cleaning Pyramid Probes, consult these Application Notes:

- *Online Cleaning Methods for Pyramid Probe Cards* - describes recommendations for online cleaning methods and procedures for determining the optimum value for online cleaning parameters.
- *Pyramid Probe Cores Off-line Cleaning With Brush* - describes procedures for offline cleaning using the brush supplied with the core.
- *Pyramid Probe Card: P800-S Online Cleaning Instructions* - describes online cleaning methods and procedures for determining the optimum value for online cleaning parameters specific to the P800-S probe.

See also Cleaning Contaminants on Pyramid Probe Cores on page 47.

Chapter

6 Maintenance and Service

Cleaning Contaminants on Pyramid Probe Cores

Pyramid Probe cores may collect contaminants that make cleaning necessary. The cleaning frequency and intensity required to keep a Pyramid Probe operating at peak efficiency is primarily related to the probing environment, and must be determined individually for each application. Pyramid Probe contaminants can be divided into two general classes:

- Particulate Contaminants
- Resistive Buildup Contaminants

Solder probing contaminants fall under the category of resistive buildup and can pose additional challenges. *See* Solder Probing Contaminants on page 48.

Particulate Contaminants

Particulate contamination can build up on the probe face and tips during probing. In some cases, particulate contamination may go unnoticed by the user, while in others it can cause persistent open channels. Large, hard particles can crush probe tips and are a leading cause of premature, catastrophic probe card failure.

Once particles have been transferred to the membrane, they are best removed by using the offline cleaning brush supplied with your core. Most loose particles can be removed with the brush. Do not use fiber swabs, which can snag probe tips, causing damage or leaving behind contaminating fibers.

For detailed instructions describing FormFactor's recommendations and procedures for offline cleaning using the brush supplied with your Pyramid Probe core, consult the Application Note *Pyramid Probe Cores Off-line Cleaning With Brush* on the FormFactor web site.

Resistive Buildup Contaminants

Resistive buildup contaminants such as organics and oxides can accumulate on the probe tips during probing. To maintain high yield, these contaminants must be removed by abrasive cleaning. For best results, this contamination should be removed preventively.

Resistive buildup contaminants do not usually damage probe tips directly. In response to the increasing contact resistance caused by this buildup, however, users may choose to apply more current or increase overtravel – both of which stress the probe tips and can cause premature probe failure.

Pyramid Probe tips do not typically experience as much resistive contaminant buildup as other probe technologies. The patented MicroScrub action of Pyramid Probes penetrates the metal oxides and cleans the probe tips with each contact. When a buildup does occur, it typically appears as a dark discoloration on one side of the probe tip.

Organic contamination or resistive buildup on the probe tips can be removed with a 3 µm diamond lapping film.

For detailed instructions describing FormFactor's recommendations and procedures for determining the optimum value for online cleaning parameters, consult the FormFactor

Application Note *Online Cleaning Methods for Pyramid Probe Cards* on the FormFactor web site.

Solder Probing Contaminants

Pyramid Probe tips used for solder ball probing are much more susceptible to accumulation of resistive buildup contaminants. Under normal probing conditions, the soft solder material sticks to the probe tip surface.

This buildup occurs with all types of solder alloys and typically appears as a dark colored mass that covers the entire probe tip surface. Often, the mass will include areas that are green, blue, brown or black. This buildup must be removed preemptively with aggressive online cleaning or yield will suffer.

Service

RMA Number

Before shipping an item to FormFactor, obtain a Return Material Authorization number (RMA #). Contact the nearest FormFactor sales office, or in the U.S call customer service at (800) 550-3279 or (503)601-1000.

The following information is required for obtaining an RMA:

- Contact information: Customer name and phone number
- The address to which the RMA items will be sent when the work is complete
- The serial number(s) of all returned items produced by FormFactor
- A list of any items not produced by FormFactor (such as PCBs, stiffeners, components, etc.)
- A description of the service required or failure indications

A signed Foreign Shipper Affidavit listing a customs value for any item produced in the U.S. must accompany shipments originating outside the U.S. For any items not produced by FormFactor, this value must be provided by the customer.

The Foreign Shipper Affidavit must be signed and included to allow your returns to pass through customs.

Repacking

To retain the validity of the warranty, always use the original packing materials. Contact a FormFactor representative for replacement shipping materials or hardware, if needed.

To pack a core for return:

1. Remove the core from the PCB (*see* Removing the Core from the Probe Card on page 23).
2. Mount the core securely in the plastic shipping box (*see* Core Box(es) on page 6).
3. Insert the box into the suspension carrier (*see* Suspension Carrier on page 6).
4. Pack the suspension carrier securely in the original shipping box.

Warranty

Repairs carry a 90-day warranty.

Chapter

7 Troubleshooting

The following suggestions are recommended starting points for troubleshooting probe problems.

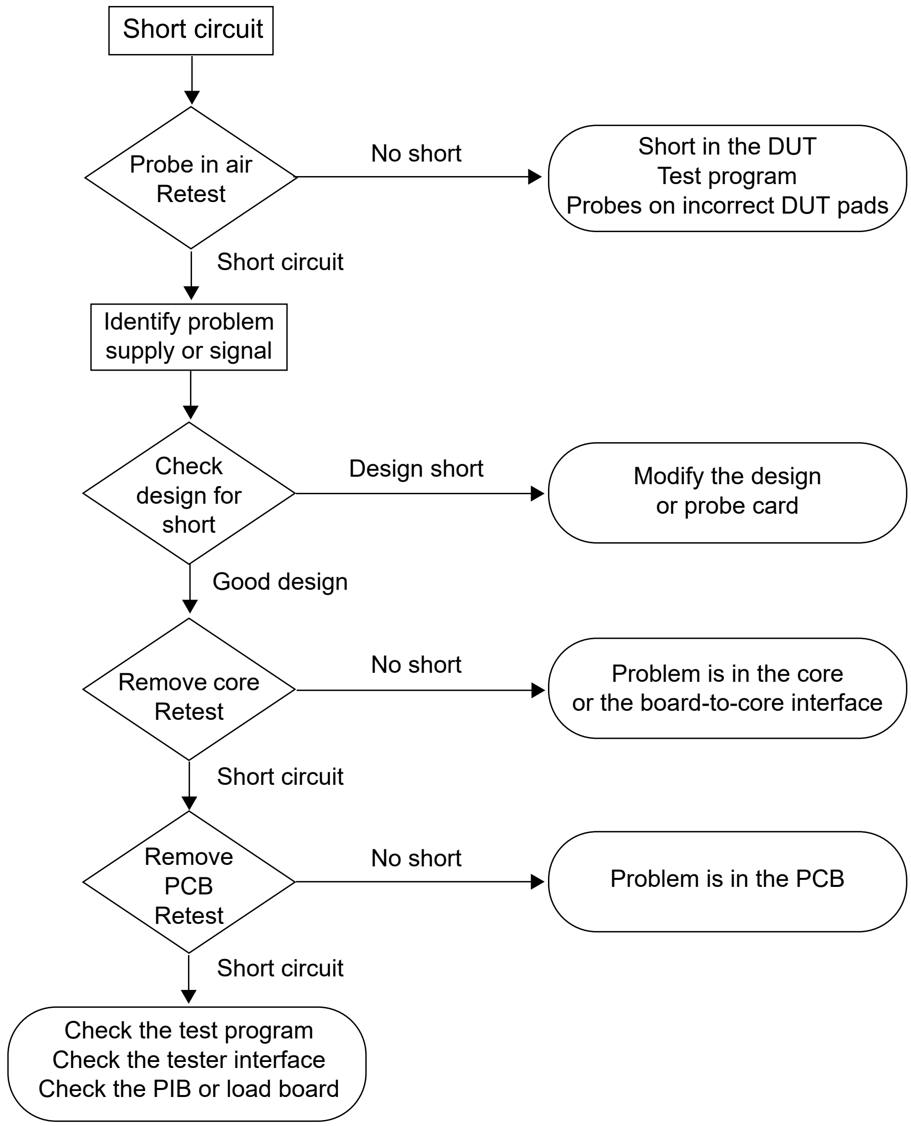
- Narrow the scope and isolate the problem
- Retest with probe tips in the air
- Remove the core to identify whether the problem can be isolated to the membrane/core

Common Operational Issues

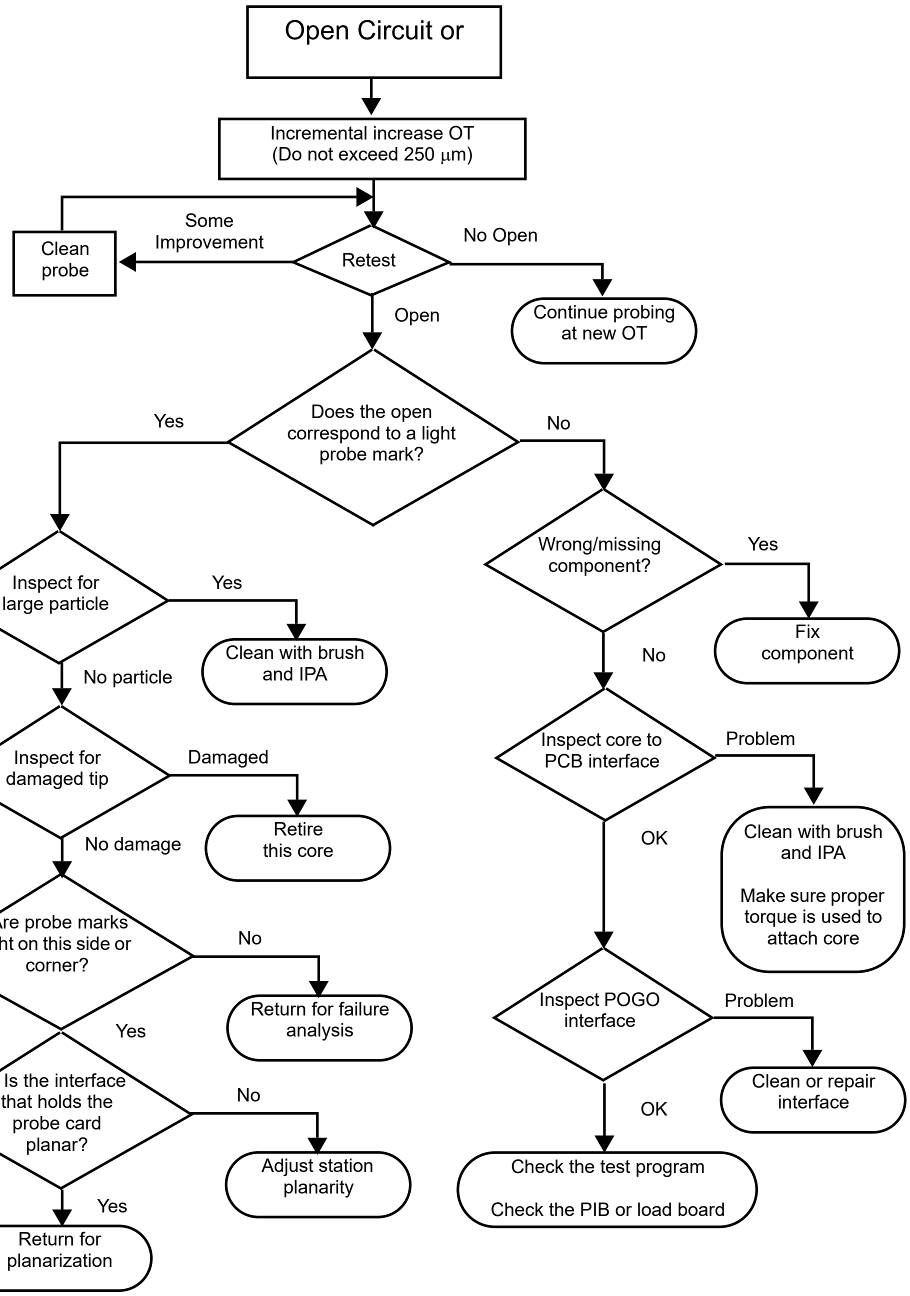
Planarity vs. cleanliness	Always check for contamination and clean the probe before adjusting the planarity of your prober. The risk associated with cleaning is far lower than that with adjusting the planarity. If planarity is adjusted to compensate for a contamination problem, severe damage may result.
High contact resistance	If a contact resistance problem improves with increased overtravel, clean the probe tips by touching down on the online cleaning pad.
Probe tip wear	Probe tip deformation is a normal aging factor associated with Pyramid Probes. It can eventually lead to metal fatigue or fractures of the tip or beam. Good contact results can often still be achieved, even in the presence of these effects.
Beam slope (probe contact)	Beam slope is measured from the nearest edge of the probe tip to the end of the beam. FormFactor does not ship probes with more than 5 µm of beam slope. A beam slope of 10 µm indicates that the probe is near its end of life. *See* Measure Beam Slope, Probe Tip Diameter, and Probe Tip Height on page 21 for measurement technique.
End of life	End of life for a probe is determined by the customer based on probe marks, contact resistance or wafer yield. Reducing the amount of overtravel and the frequency of cleaning cycles can extend probe life.

Short Circuits and Leakage

The following chart describes suggested procedures for troubleshooting short circuits.



Open Circuit or High Contact Resistance



Index

Corporate Headquarters
7005 Southfront Road
Livermore, CA 94551
Phone: 925-290-4000
www.formfactor.com