> User Guide

Pyramid Core Cleaning Guide

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Contents

Overview 1

Particulate and Resistive Buildup Contaminants 1
Pyramid Core Sizes 3
Handling 4
Tools 4
Data and Certificate of Conformance 5
Support Documents 6
Notational Conventions 7
For More Information 7

Offline Core Cleaning with a Brush 8

Required Materials 8
Pyramid Core Cleaning Brush 8
Membrane Cleaning Solvent 9
Safety Guidelines 9
Four-Step Cleaning Process 10

Online Cleaning 12

General Online Cleaning Method 12
Selection of Cleaning Media 13
System Configuration 16
Prober Software Settings 16
Auxiliary Chuck 17
Online Cleaning Parameters 17
General Precautions 17
Online Cleaning Frequency – Yield vs. Wear 18
Overtravel 18
Procedure: Determining Cleaning Parameters 18
Initial Cleaning Recipe Settings for P800-S Cores 20
Initial Cleaning Recipe Settings for P2000 Cores 20
Troubleshooting 21
Offline Cleaning Methods 22
Brush Cleaning 22
Abrasive Cleaning 22
Service 22

Overview

Welcome to the Pyramid Core Cleaning Guide. This document describes the recommended procedures for cleaning and maintaining Pyramid Probe cores and Probe Card assemblies. The procedures described here are intended for use by trained personnel. Pyramid Probe cores are part of a family of FormFactor products that are intended for use in probing devices that operate at high frequency. The product uses a unique membrane space transformer with embedded probe tips, enabling a high performance, low loss connection from the tester to the device-under-test (DUT) for high-speed and RF signals. Probe tips come in a variety of dimensions to suit specific applications.

This guide is divided into two main sections:

- **Offline Cleaning:** This describes the cleaning of the core and the probing surfaces with solvent and a special cleaning brush to remove any **particulate buildup** and any other residues that require a solvent and gentle brushing to remove. Offline Cleaning is accomplished when the core is removed from the Probing PCB and the prober.
- **Online Cleaning:** This describes the cleaning of the core tips using an abrasive cleaning media to remove any buildup of oxides, organic materials, or metal deposits on the tips that would be likely to impact Contact Resistance that would result in degrading DUT test yield. Online Cleaning is accomplished in the prober by stepping the platen to a special cleaning area of the chuck where the cleaning media is mounted.

Particulate and Resistive Buildup Contaminants

Pyramid Probe contaminants can be divided into two general classes:

- Particulate Contaminants
- Resistive Buildup Contaminants (Organics, Oxides, and Solder)

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.

Particle On Tip
(Likely Open)

Repeating Particle Indent
(Near Miss)

Deep Particle Indent
(Three Open Traces)

Particle Hit
(Probe Tip Damage)

Examples of Particle Contamination and the Effects

Once particles have been transferred to the membrane, they are best removed by using the FormFactor cleaning brush, Part Number 113-477 and the offline cleaning procedure contained in this document. The brushes are available for purchase from FormFactor Beaverton or contact your local Field Applications Engineer to see if they might have brushes available.

The best solution for particulate contamination is prevention of the particles at their source. A few simple precautions can protect Pyramid Probes from particulate damage. To avoid accidental damage to the probe core:

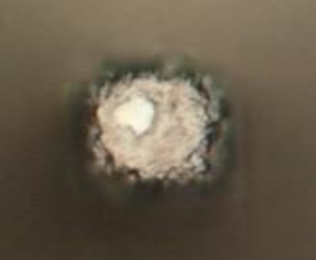
- Probe in a clean room environment
- Wash wafers immediately before probing (particularly after laser scribe operations)
- Use extreme caution when probing correlation wafers.
- Do not load or unload probe cards with the wafer on the chuck.
- Do not share brushes between Pyramid Probes and other probe card technologies
- Do not probe wafers that have been stored in an unclean environment
- Do not touch the membrane, even with gloved hands
- Perform regular preventative maintenance to clean the wafer area of the prober

Resistive Buildup Contaminants (Organics, Oxides, Solder)

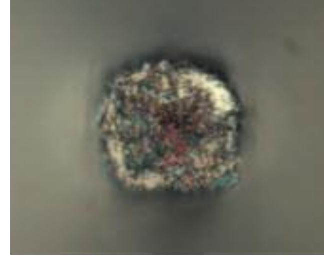
Resistive buildup contaminants such as organics and oxides can accumulate on the probe tips during probing. To maintain high yield, these contaminants must be removed by abrasive cleaning. For best results, preventive measures should be taken to remove this contamination. Resistive buildup contaminants do not usually result in direct probe tip damage, but can result in increased contact resistance. To compensate, users may choose to increase overtravel, which can stress probe tips and cause premature probe failure.

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

Clean Probe Tip

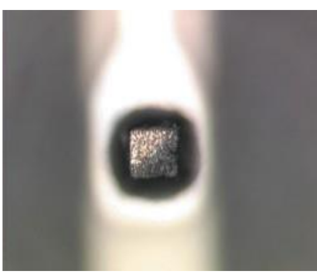


Aluminum Buildup



Copper Buildup

Probe tips for solder ball probing are much more susceptible to accumulation of resistive buildup contaminants. Under normal probing, the soft solder material sticks to the probe tip surface. This buildup typically appears as a dark colored mass that covers the entire tip surface and occurs with all types of solder alloys. Often, the mass will include areas that are green, blue, brown, or black. Yield will suffer if this buildup is not removed preemptively with aggressive online cleaning.



Solder Buildup

Pyramid Core Sizes

Metric	Unit	RFC	MSI	P800s	P2000s
Max probe face area	mm	5.3 x 5.3	9.7 x 9.7	11.5 x 37.4	9.4 x 50.0
Max probe draft	mm	6.2	11.2	11.2	11.2
CBI pad count	#	108	408	804	2112
CBI pitch	µm	465 single row	381 (A-row); 952 (B,C,D-rows)	381 (A-row); 953 (B,C,D-rows)	400 all rows
Contact surface	Material	Pad/Solder	Pad/Solder	Solder	Solder
Force/pin @ Recommended OD	gf	10 - 15	10 - 15	10 - 20	10 - 20
Max frequency (Return Loss <-10dB)	GHz	81	81	67	67
Max RF power @ 1 GHz	dBm	40	40	40	42
Max RF ports	#	52	92	116	260
Max current/tip	mA	200	200	200	200
PH temp range	°C	-40 to 125	-40 to 125	-40 to 125	-40 to 125
Membrane metal layers	#	2	2	2	3
Min pad pitch (full array)	µm	130	130	130	130
X/Y alignment	µm	+/- 10	+/- 10	+/- 10	+/- 10
Planarity specification	µm	150 max FTL	150 max FTL	<15 tip co-planarity	<15 tip co-planarity

Handling

Follow these guidelines to protect your probe core from damage:

- Handle the probe core carefully. Probe tips are sensitive and can be damaged by accidental contact.
- Wear gloves when handling the probe core.
- Always use the protective probe head cover when transporting or storing probe cores.
- Store the probe core in its container when it is not in use.
- Store the probe core in a class 10,000 (or better) clean room environment, with a controlled temperature of 20ºC at 40% humidity.
- Always follow proper electrostatic discharge (ESD) precautions. Wear appropriate grounding straps and avoid capacitive materials when handling probe cores and cards.
- Follow the safety procedures outlined by your facility for a safe work area.

Tools

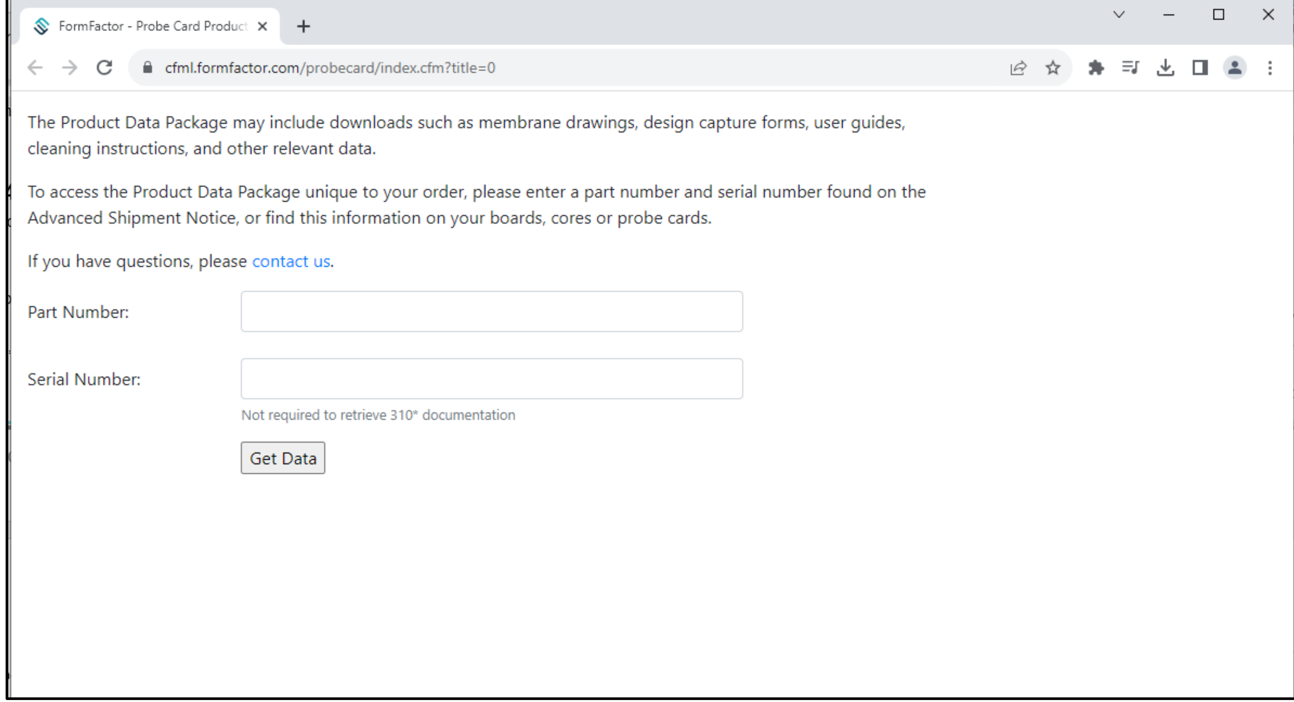
These tools may be required to complete the procedures described in this guide:

- FormFactor Cleaning Brush, Part Number 113-477
- Clean, dry air (CDA), 15 psi max
- 64 in-oz x 3/32-inch torque wrench
- 3/32-inch hex wrench (or Allen wrench)
- IPA (isopropyl alcohol) or methanol. Methanol is appropriate only for low leakage applications; dispensing from a squeeze bottle is preferred
- Low power stereo zoom microscope
- Tweezers, Excelta 3 CS, or similar
- Cleanroom wipes
- Cleanroom gloves
- Appropriate Cleaning Media for the Core and Application

Data and Certificate of Conformance

Data for any Pyramid Core can be downloaded from the FormFactor Website at:

https://cfml.formfactor.com/probecard/index.cfm?title=0
After clicking the link, the following web page will appear.



To download the data package, enter the part number and serial number of the core in the spaces provided and click "Get Data." The download will begin.

Please note that a serial number is not required for 310-xxxx-xx part numbers (Custom ISS Products).

Besides data, various supporting documents are included in the data package, including the Certificate of Conformance.

If the above link is not working for some reason, use this link instead:

https://www.formfactor.com/sales-service/product-support/pyramid-probe-card-support/

Click on "PRODUCT DATA PACKAGE" and follow any instructions provided to obtain the required information.

Support Documents

A variety of supporting documents such as the RF Probe Order Form and Cleaning Guides can be downloaded from the following link by clicking on "DOWNLOADS".

https://www.formfactor.com/sales-service/pyramid-probe-card-support/

After clicking the link, the following web page will appear:

Pyramid Probe Card Support | Fo

formfactor.com/sales-service/pyramid-probe-card-support/

FORMFACTOR™ PRODUCTS APPLICATIONS INDUSTRIES SALES & SERVICE COMPANY

Sales & Service > Pyramid Probe Card Support

Pyramid Probe Card Support

Find service and support information for your production probe cards such as FAQs, training, and product specific downloads (membrane drawings, design capture forms, user guides, cleaning instructions, and other relevant data).

TRAINING & CERTIFICATION | PYRAMID PROBE CARD FAQS | PRODUCT DATA PACKAGE | DOWNLOADS

CONTACT US

Maximize the Performance of Your Pyramid Probe® Card

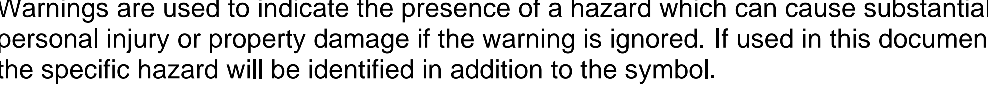
Advances in semiconductor design, as well as the rising expense of bringing new devices to market, have increased the importance of ensuring the longevity of test and measurement tools. Regularly scheduled maintenance and proper cleaning procedures can have a significant impact on extending the life of probe cards, which in turn can improve test throughput and yield. FormFactor offers a variety of training programs, including hands-on training at your location, to help your team optimize probe card performance. Our program is designed to provide Pyramid Probe customers the knowledge and skills required to ensure optimal Pyramid Probe performance and realize maximum useful life in engineering and production test environments.

Training and Certification Programs Site Review and Recommendation Report

A Site Review consists of inspection and assessment of test floor, equipment and procedures. Best practice recommendations implemented from this review can improve the overall performance and life of the Pyramid Probe card as well as other probing technology.

Notational Conventions

This manual uses the following conventions.

Symbol	Name/Meaning
	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.
	 **WARNINGS** Warnings are used to indicate the presence of a hazard which can cause substantial personal injury or property damage if the warning is ignored. If used in this document, the specific hazard will be identified in addition to the symbol.
	DANGER Danger is used to indicate the presence of a hazard which can cause severe injury or death.

For More Information

More information may be available from these sources:

- BMS-04-080-0001, Pyramid Core User Guide
- BMS-04-080-0002, Pyramid Core Inspection Guide
- BMS-04-080-0003, Pyramid Core Planarity Adjustment Guide
- BMS-04-080-0005, Pyramid Probe PCB Cleaning Guide
- BMS-04-080-0006, Pyramid Core Planarity Gauge User Guide
- Your probe station or autoprober user guide
- FormFactor's website at www.formfactor.com
- If you purchased your FormFactor product from a third-party vendor, contact that vendor for service and support

Offline Core Cleaning with a Brush

To protect your investment, prevent probing errors, and avoid device damage, follow the procedures described in this section for offline cleaning of your Pyramid Probe core. This guide provides a comprehensive overview of the required materials, as well as a detailed description of the four-step cleaning process. To ensure the best results, follow all the directions thoroughly.

Required Materials

Brush	• FormFactor Cleaning Brush, Part Number 113-477 These can be ordered from FormFactor as part of the core order. Contact your local Field Applications Engineer for assistance in obtaining brushes or getting a quotation for brushes.
Solvents	• Isopropyl alcohol (2-propanol) CMOS grade, 99.5% • Methanol CMOS grade
Equipment	• CDA (clean, dry air) or N_2 (nitrogen) nozzle regulated to 40 psi maximum (2.75 bars or 275 kPa) • Low-power, stereo-zoom microscope • Ring lighting works best • 10x to 50x zoom range • Clean-room gloves

The FormFactor Cleaning brush listed in the Required Materials is the only recommended brush for Offline Core Cleaning. Other brushes can cause damage to the core or membrane and should be avoided. Follow the guidelines below for the use and care of the celaning brush and do not use the brush with other probe technologies. Debris and contaminants from these other probe technologies can degrade the brush performance or transfer unwanted particles and contaminants to the Pyramid Core, resulting in poor performance.

Pyramid Core Cleaning Brush

Approved brush	When cleaning a Pyramid Probe core or PCB, only use a brush provided by FormFactor under part number 113-477. Or Not a brush like this:
Brush care	• The brush should only be used on Pyramid Probe cards. • Contaminates from a brush used on another type of probe card can damage the Pyramid Probe. • When not in use, store the brush in the provided vinyl package.
Replace the brush if:	• It is accidentally used on any other type of card. • It shows signs of wear (bristles change color or fall out). • It is dropped on floor. • It deposits particles rather than removes them.

Membrane Cleaning Solvent

- Use only isopropyl alcohol (2-propanol) CMOS grade, 99.5% (IPA) or methanol CMOS grade when cleaning Pyramid Probes.
- Use methanol only when cleaning low leakage Pyramid Probe Cores
- Always use IPA and methanol out of a squeeze bottle and not out of a reservoir due to risk of contamination of the brush

Safety Guidelines

- Wearing gloves is recommended when handling Pyramid Probe cards
- Avoid touching the probe face or probe tips with the metal ferrule or handle of the brush
- Never clean the sides (wings) of the core. Only clean the probe face
- Use a maximum of 40 psi (275 kPa) air-nozzle pressure on Pyramid Probe cores
- Before any type of cleaning, always inspect the Pyramid Probe core placed on a flat surface, wafer-side up, under the microscope

Four-Step Cleaning Process

1. Inspect the core using a microscope.
2. Ensure that the brush is clean to avoid causing damage or adding particles to the membrane.
3. Moisten or loosen any particles or residue on the probe face, then remove the particles or residue with strokes of the cleaning brush.
4. Blow the remaining IPA or methanol (containing particles/residue) away from the probe face.

Figure 1

Figure 2

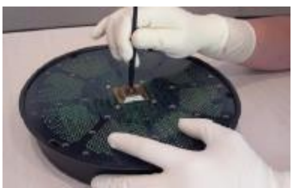


Figure 3

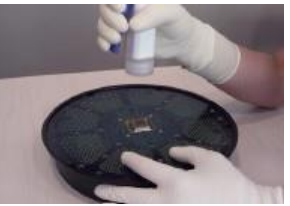


Figure 4

Step 1: Inspect the Core

Inspect the core under the microscope for any damage and/or loose particles.

- If loose particles are found, hold an acceptable air nozzle vertical to the probe face, three inches (75 mm) from the core (see Figure 4). Activate the air stream before approaching the core with the air nozzle, as the nozzle will tend to move forward even at low pressure. Continue to Step 2: Preparing the Cleaning Brush.
- If no loose particles are found, go directly to Step 2: Preparing the Cleaning Brush.

Step 2: Prepare the Cleaning Brush

Complete the following steps to ensure that the brush is clean and you are not adding particles to the membrane or causing damage:

1. Aiming the air nozzle away from the microscope and work area, blow out any debris in the brush head (see Figure 1).
2. Use a squeeze bottle of IPA or methanol to wet the brush (see Figure 2), and then blow out the brush head again (see Figure 1).

Step 3: Clean With Brush

Complete the following steps to moisten or loosen any particles or residue on the probe face. Then remove the particles or residue with strokes of the cleaning brush.

1. Use a squeeze bottle of IPA or methanol to re-wet the brush.
2. Hold the brush vertical to the probe face (see Figure 3).
3. Starting from either the left or right side of the probe face (see Figure 3), use a circular motion to clean across the probe face and back again. Use enough force to feel the probe tips. If the brush tip begins to dry, apply more IPA or methanol. Do not allow the brush to dry out.
4. Clean the brush again, according to the steps described in Step 2: Preparing the Cleaning Brush.
5. Re-wet the brush and use smooth brush strokes to wipe the probe face from edge to edge. DO NOT use a back and forth motion.
6. Repeat from top to bottom to remove particles from entire probe face.

CAUTION

Do not allow the alcohol to dry between steps 3 and 4.

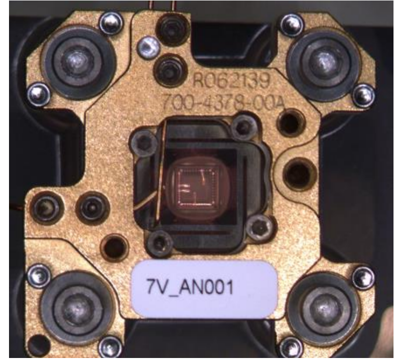
Step 4: Blow Away Particles and Solvent

Complete the following steps to blow the remaining IPA or methanol containing particles/residue away from the probe face.

1. Hold an acceptable air nozzle vertical to the probe face, three inches (75 mm) from the core (see Figure 4). Activate the air stream before approaching the core with the air nozzle, as the nozzle will tend to move forward even at low pressure.
2. Continue blowing air on the probe face until it is visibly dry, approximately 30-60 seconds.
3. Return to Step 1: Inspecting the Core, and repeat steps 2, 3 and 4 until all particles have been removed.

Online Cleaning

Particulate contamination can build up on the probe face and tips during probing, resulting in damage and poor performance. This section of the Pyramid Core Cleaning Guide describes the materials and methods recommended for online cleaning of Pyramid Probe Cores.



Pyramid Probe RFC Core with Plastic Plunger

P800-S Core with Steel Plunger

General Online Cleaning Method

The most effective method for controlling contact resistance (R_C) and cleaning resistive buildup from Pyramid Probe tips is online cleaning performed by touching down on an abrasive cleaning pad. The specific abrasive material, the number of touchdowns on that material, and the overtravel used for cleaning are all variables that need to be selected carefully to maximize the effectiveness of the cleaning and to maximize the lifetime of the probe core.

CAUTION

Excessive use of abrasive cleaning media may cause premature failure of Pyramid Probes.

Online leaning of Pyramid Probe Cores requires the development of an Online Cleaning Process Recipe or Formula to accomplish the goals of maximizing the effectiveness of the cleaning and the lifetime of the probe core. There is no one recipe or formula that fits all core use cases, so it is important to have a controlled process for the development of the recipe or formula for Online Cleaning.

The basic formula consists of the following:

- Selection of an abrasive cleaning media
- Determining the number of wafer touchdowns between cleaning cycles
- Determining the number of cleaning media touchdowns and overtravel on the cleaning media that results in sufficient cleaning results.
- Testing and verifying the formula and making adjustments as needed.

The local FormFactor Field Applications Engineer (FAE) can assist with determining a starting point for the cleaning recipe and provide assistance in making adjustments and corrections as needed to help with the optimization of the recipe.

Selection of Cleaning Media

Recommended Cleaning Media

Abrasive cleaning media can be divided into four categories, described in Table 1.

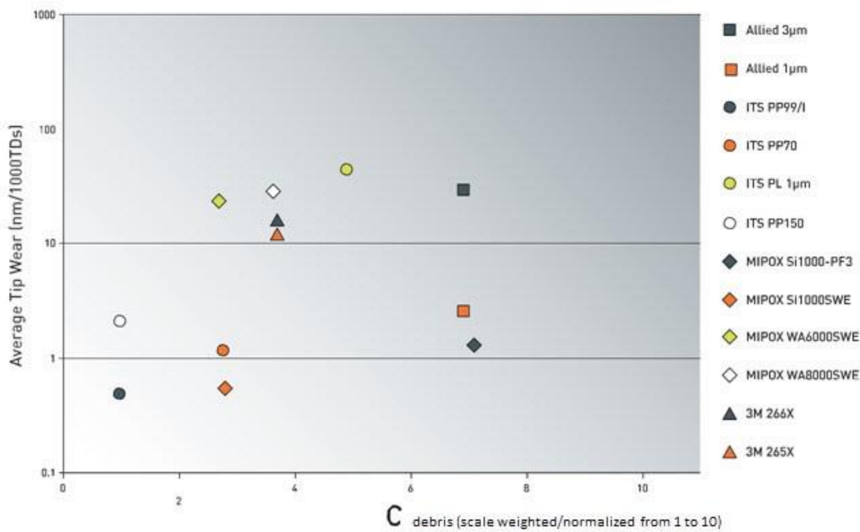
Table 1. Abrasive Cleaning Media

Media	Description
Abrasive coated foams	The most common source for abrasive coated foams is MIPOX International. Abrasive coated foams consist of a layer of abrasive particles in a resin binder. Instead of being bonded to a polyester film carrier like a lapping film, the particles are coated onto a soft, open celled foam. Abrasive coated foams have demonstrated good results. However, a tendency to round probe tips has resulted in increased pressure on the pad, potentially requiring a requalification if used on pad-over-active-area (POAA) or low-K dielectric devices. Abrasive coated foams should be acceptable for all other applications. (Drawing courtesy of MIPOX) **Abrasive Coated Foam Architecture** **NOTE** *MIPOX International's WA6000-SWE is the only recommended cleaning material for P800-S and larger Pyramid Probes.*
Abrasive loaded elastomers	Abrasive loaded elastomer media consist of a relatively thick layer of elastomer [such as silicone, polyurethane, or rubber) with abrasive particles mixed evenly throughout the polymer. This gel-like film is generally mounted to a polyester backing film or a cleaning wafer. The most common source of this type of cleaning film is International Test Solutions (ITS). Abrasive loaded elastomers are expected to be safe for use. **NOTE** *Abrasive coated elastomers are considered "Acceptable" for P-800S and larger cores but are not recommended. FormFactor recommends the use of Abrasive Coated Foams for P800S and larger cores.*
Lapping films	Lapping films are the traditional method used for cleaning cantilever probe cards. Lapping film contains abrasive particles that have been bonded to a polyester backing film with a relatively hard resin binder. These films are typically 75-125 µm thick. No correlation has been found between overtravel on lapping films and tip wear on Pyramid Probes. In fact, there is a strong correlation between high cleaning overtravel and particle generation. The minimum overtravel for good results is recommended. All lapping films have been observed to generate particles (from the binder attaching the abrasive particles to the backing) during the cleaning process. **NOTE** *The only acceptable soft backed, lapping film is MIPOX Si10000-PF3, as the abrasive (SiO_2) is softer than the Pyramid Probe tips, making damage unlikely. Soft backed lapping films should be used only for cores smaller than P-800S.*
Elastomeric substrates ("tacky mats")	Elastomeric substrates clean by removing particles from the probe tips by adhesion. These materials can adhere to the membrane itself. The ITS Probe Clean is safe for use and does not change the planarity or probe tip position. Recommended overtravel is 30 to 75 µm. **NOTE** *Elastomeric substrates should not be used for P800S or larger cores.*

Table 2. Cleaning Film Wear Rates (Per 1000 Touchdowns)

Manufacturer	Product	Type	Wear Rate (nm/1k TDs)
MIPOX	Si10000-SWE	Abrasive Coated Foam	0.5
ITS	Probe Polish 99/I (PP-9903SC/I-M)	Abrasive Loaded Elastomer	0.6
MIPOX	Si10000-PF3	Soft-Backed Lapping Film	1.3
ITS	Probe Polish 70 (PP-7003SCM)	Abrasive Loaded Elastomer	1.5
ITS	Probe Polish 150 (PP-150SCM)	Abrasive Loaded Elastomer	2.6
Allied High Tech Products	Diamond Lapping Film, 1 µm (50-30145)	Lapping Film	2.6
3M	Imperial Lapping Film, 1 µm (265x)	Lapping Film	11.7
3M	Imperial Lapping Film, 3 µm (266x)	Lapping Film	15.5
MIPOX	WA-6000-SWE	Abrasive Coated Foam	23.6
MIPOX	WA-8000-SWE	Abrasive Coated Foam	28.8
Allied High Tech Products	Diamond Lapping Film, 3 µm (50-30140)	Lapping Film	29.9
ITS	Probe Lap, 1 µm (ITS-PL-A1H))	Lapping Film	54.6

Tested Cleaning Films: Tip wear and Debris Generation



Abrasive cleaning media are available from these suppliers. Contact the supplier directly for application specific recommendations and product support.

- International Test Solutions (ITS) (www.inttest.net) – offers a broad range of probe card cleaning products
- MIPOX International Corporation (www.mipox.co.jp/en/contact/index.html) – offers probe card cleaning sheets with foam backing materials, in a variety of abrasives and grit sizes.

NOTE
Sheets of MIPOX WA6000-SWE (9 x 11-inch) are available directly from MIPOX (P/N WA6000-SWE FWX w/PSA).

- 3M (www.3m.com/electronics) – offers lapping films in a variety of abrasive materials, grit sizes, and resin hardness

Unacceptable Cleaning Media

The cleaning methods described Tables 3 and 4 can cause irreversible damage to Pyramid Probe tips. These methods must not be used with Pyramid Probe products under any circumstances.

Table 3: Unacceptable online cleaning materials

Media	Description
Tungsten Carbide, Silicon Carbide, Alumina, or other Ceramic Plates	Even if they are similar to the Allied 3 µm diamond lapping film in grit size, probing on these surfaces will quickly grind away Pyramid Probe tips.
Non-qualified chemicals	Many chemicals are incompatible with the materials used in Pyramid Probe cores. See the section on offline cleaning with a brush for a list of qualified chemicals.
Soft backed lapping films	In general, soft backed lapping films should be avoided. Use of soft backed lapping films applies uneven pressure to the probe tips causing uneven wear, degrades coplanarity (especially at the edges or corners of an array of tips), and increases the overtravel requirement over time. In addition, too much overtravel is required to contact all the probe tips. This type of cleaning material should not be used to clean Pyramid Probes. Examples of soft backed lapping films include: • MIPOX PF3 types, for example, GC6000-PF3 and GC8000-PF3, SI10000-PF3 • 3M Type CL (cushion layer) • Stacked layers of cleaning films to create the equivalent of a soft backed lapping film
Lapping films with the abrasive contained in ceramic beads	The large ceramic beads can damage the probe tips. The beads are also brittle and can shatter, causing contamination on the face of the probe. This type of cleaning material should not be used to clean Pyramid Probes. Examples of lapping films with ceramic beads containing abrasive include: • Allied High Tech Products, Type B lapping films • 3M Type B lapping films

Table 4. Unacceptable cleaning materials and damage likely to occur.

Manufacturer	Product	Type	Note
Allied High Tech Products	Type B Diamond Lapping Film, 1 µm (50-30145B)	Lapping Film	Damaged Tips
Allied High Tech Products	Type B Diamond Lapping Film, 3 µm (50-30140B)	Lapping Film	Damaged Tips
Allied High Tech Products	Type B Diamond Lapping Film, 6 µm (50-30135B)	Lapping Film	Damaged Tips
Allied High Tech Products	Diamond Lapping Film, 6 µm (50-30135)	Lapping Film	Extreme Debris
3M	Imperial Lapping Film, Cushion Layer, 3 µm (T-CL)	Soft-backed Lapping Film	Uneven Wear
MIPOX	GC6000-PF3	Soft-backed Lapping Film	Uneven Wear
MIPOX	GC8000-PF3	Soft-backed Lapping Film	Uneven Wear

Uncharacterized Cleaning Materials

The common industry cleaning methods discussed in Table 5 can pose potential issues when used with Pyramid Probes. However, these methods may be acceptable in certain applications. Contact FormFactor for application support before implementing any of these methods.

Table 5. Uncharacterized cleaning materials

Media	Description
Other lapping films	Lapping films are available from a number of manufacturers. Grit material, relative grit density, backing film hardness, bond resin hardness, and other variables affect the suitability of each film for cleaning Pyramid Probe core tips. FormFactor makes no specific recommendations regarding the suitability of these films.
Prober mounted brushes	These brushes may contaminate or scratch the probe face surface or cause other damage. Brush cleaning settings in some prober/probe configurations can drive the probe into the side of the cleaning chuck, causing irreparable probe damage. Before using prober brushes to clean Pyramid Probe cards, contact a FormFactor representative to determine appropriate prober configurations and settings.

System Configuration

Prober Software Settings

CAUTION

Probers can destroy Pyramid Probes! Consult your FormFactor representative if you have any doubt regarding the correct prober software settings to use with Pyramid Probes.

Although the basic functionality is the same for all probers, the terminology to set probe cleaning parameters varies between manufacturers. Familiarize yourself with the terminology, parameter names, and capabilities of your specific prober before setting up a Pyramid Probe.

CAUTION

Take note of these prober-specific cautions to avoid damaging your probe.

Prober	Caution
EG2001	Use only “Z-Drive” or “Axis” mode for cleaning Pyramid Probes. “Probe Polish” mode is a circular motion that will quickly grind the probe tips away.
EG4090	The CPCS capacitive overtravel zeroing feature is not compatible with Pyramid Probes. There are known cases of crashed probe cards from the CPCS feature incorrectly detecting the probe tip height.
Accretech (TSK) UF200/ UF3000/ APM90	The Accretech variable “SHIFT BETWEEN TOUCHDOWNS” refers to total distance traveled during a cleaning instruction, rather than the incremental step size from one cleaning touchdown to the next. The incremental step size is this value divided by the number of cleaning touchdowns per cycle. “SHIFT BETWEEN TOUCHDOWNS” must be large enough to make the incremental step size larger than the probe tip diameter
	Consult your prober documentation and make sure the settings are correct before executing any procedure described in this document.

Table 6. Prober specific settings

Prober	Settings
Electroglas (EG)	• Clean Type (set to “Z Only” for Pyramid Probe cards) • Clean Every Nth Touchdown • Stroke Length • Number of Strokes • Location of Clean
Tokyo Electron (TEL)	• Contact Count for Needle Polish • Same Position Contact Count • Polisher Upper Limit • Execution Interval
Accretech (TSK)	• Wafer Interval • Die Interval • Cleaning Contact Interval • Number of Touchdowns per Cleaning • Shift Between Touchdowns

Auxiliary Chuck

Probers with an auxiliary cleaning chuck offer more online cleaning options. When an auxiliary chuck is available, the cleaning film can be applied either directly to the chuck, or to a removable substrate held by the prober. Here, the cleaning interval is the probe insertions between cleanings (or die tested with a single DUT probe). An auxiliary chuck provides the flexibility to set the cleaning interval as frequently (or as infrequently) as necessary, with little impact on the production flow.

If the prober has no auxiliary chuck, the cleaning medium must be applied to a wafer loaded into the prober in place of a product wafer. To avoid unnecessary setups, the cleaning interval here is typically the wafers tested between cleanings, which may not be enough cleaning to maintain yield.

Online Cleaning Parameters

General Precautions

When using a prober or cleaning station, never clean Pyramid Probe cards by moving the cleaning chuck back and forth in the XY plane when it is in contact with the probe tips. Instead, clean the probe tips contacting the cleaning substrate using only a Z axis motion. Many probers and probe card analyzers default to a scrubbing XY motion, which must be disabled.

CAUTION
When cleaning Pyramid Probe cards, never move the cleaning substrate in the XY plane when the substrate and the probe tips are in contact.

When stepping Pyramid Probe cards down on a cleaning substrate, do not exceed 250 µm in overtravel. Overtravel between 35 and 75 µm is optimal for most cleaning applications. Higher overtravel is more likely to generate particles from the cleaning film.

Step the cleaning chuck at least 2x the tip diameter in the X and Y directions between touchdowns to ensure the probe tips always contact fresh material and an even distribution of abrasive particles.

Online Cleaning Frequency – Yield vs. Wear

Each time a probe card is cleaned abrasively, a small amount of probe tip material may be removed in addition to the contaminant. The cleaning frequency and intensity required to keep a Pyramid Probe operating at its peak efficiency are primarily related to the probing environment. As a result, the exact formula for cleaning Pyramid Probes must be determined individually for each application. When developing a cleaning strategy for probe cards, a trade off is made between the lifetime of the probe card and the test yield. Yield suffers if the probing-to-cleaning ratio is set too high.

Alternatively, probe card lifetime and test equipment utilization suffer if the probing-to-cleaning ratio is set too low. When developing the cleaning strategy, the objective is to determine a probing-to-cleaning ratio low enough to minimize probe tip wear, but high enough to maximize yield.

LOWER
- Higher Yield
- Shorter probe lifetime

PROBING TO CLEANING TOUCHDOWN RATIO

HIGHER
- Lower Yield
- Longer probe lifetime

Overtravel

If all the tips are in contact, increasing cleaning overtravel on Pyramid Probe tips does not increase the foreign material removal rate. In fact, higher cleaning overtravel may accelerate the accumulation of particles from the cleaning substrate.

Set the overtravel high enough to ensure that all tips contact the film, but low enough to minimize particle generation from the film. Typical cleaning overtravel used in a factory environment is 35 to 75 µm.

Procedure: Determining Cleaning Parameters

CAUTION
Difficulty autofocusing on the probe tips can cause a discrepancy between actual and programmed overtravel, leading to poor cleaning performance.

NOTE
The cleaning parameters described here are guidelines only. Optimized cleaning parameters for the best yield and lifetime must be end user developed in the actual probing environment.

Follow these steps to determine cleaning parameters (cleaning interval, touchdowns per clean, and cleaning overtravel):

1. Ensure that the proper cleaning medium is installed on the cleaning chuck or wafer.
2. Verify that the prober is set for the correct height offset, or that it will detect the height of the cleaning surface optically.
   a. ITS Probe Lap varies in thickness from 104 to 120 µm thick.
   b. MIPOX International's WA6000-SWE film thickness varies from 470 to 500 µm.
3. Examine the probe tips under a microscope. Magnification levels of 500 to 1000x and bright field lighting are optimal. Probe tips should be free of debris. Verify probe tip dimensions using the Certificate of Conformance and other technical documents provided or downloaded from FormFactor.

Example: probe tips for oxidizing metals (aluminum, copper and solder)

4. After probe card inspection, load the probe card onto the prober.
5. Verify the prober cleaning settings:
   a. Cleaning type set to Z only
   b. XY increment between cleaning touchdowns at least 2 times the tip diameter
6. Select the initial cleaning overtravel, typically 35 to 75 µm (50 µm is recommended).

CAUTION

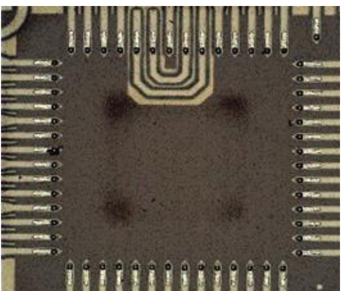
Difficulty auto focusing on the probe tips can cause actual and programmed overtravel to be different. This can lead to poor cleaning performance.

7. Determine the cleaning interval:
   a. Probe until a yield drop occurs.
   b. Clean the probe tips well, with 150-500 cleaning cycles. Start with 150-200 and increase as needed.
   c. Repeat step a and step b until you can predict the number of die probed before a yield drop.
   d. Set the cleaning interval to approximately 75% or 80% of the average number of touchdowns before yield drops.
8. Determine the number of touchdowns per cleaning cycle.
   a. Choose an initial value. This number is typically between 25 and 30.

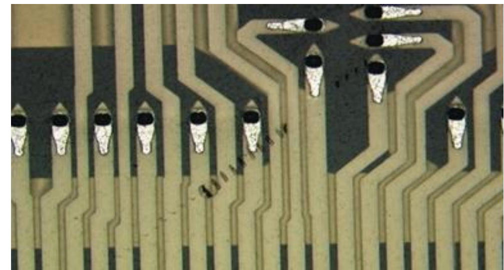
NOTE

More cleaning touchdowns may increase the number of die between cleaning cycles. Consider starting with 150 to 200 cleaning touchdowns, especially for solder ball probing. Contact the local FormFactor Field Applications Engineer for assistance.

   b. Probe several cleaning cycles to validate a stable process.
   c. Reduce the number of cleaning touchdowns by approximately 20%.
   d. Repeat step b and step c until the yield cannot be maintained for the entire probing cycle.
   e. Increase the number of cleaning touchdowns to the previous larger number.
9. Remove the probe card and examine the probe tips under a microscope for signs of contamination. See Contaminants on page 1 for details on contamination types.



Lapping film abrasion on membrane



Repeating particle indent, near miss

Initial Cleaning Recipe Settings for P800-S Cores

Experiments were performed in the factory on solder covered wafers to establish a cleaning recipe to use as a starting point for customers probing solder balls with P800-S Pyramid Probes. Contact resistance was monitored while the number of cleaning touches was varied. Cleaning cycles were made after every 200 contact resistance measurements. A ratio of probing contacts to cleaning contacts was calculated for each recipe. The tested ratios were 1:1, 2.5:1, 5:1, and 10:1. The results showed that the highest ratio of probing to cleaning that maintained less than 0.5 ohms increase in contactresistance was 2.5:1; or 80 cleaning cycles for every 200 measurements. A cleaning recipe can be created using the process described in this document, or by starting with these values and refining them based on yield.

Proposed Starting Recipe for P800-S (Solder Ball Probing)

- Die touchdowns between cleaning cycles: 200
- Cleaning touchdowns per cycle: 80
- Overtravel on cleaning media: 50 µm
- Cleaning media: MIPOX WA8000-SWE

Initial Cleaning Recipe Settings for P2000 Cores

Detailed cleaning recipes for CRES maintenance must be developed by the end user to optimize the performance for the specific application.

The following cleaning settings may be used as a starting point:

- Cleaning Material: Mipox WA6000 SWE
- Cleaning Interval: 20 DUT Touchdowns
- Cleaning Touchdowns: 20 Cleaning Touchdowns
- Cleaning Overtravel: 50 µm POT
- Cleaning Index: Should not equal die step size to avoid repeat probe tip contact locations. It may take some effort to determine the best cleaning index to obtain the bes overall results. Consult with the local FormFactor Field Applications Engineer for assistance.

After running the core with the starting point cleaning recipe, optimize the recipe as needed. The goal is to maximize the Cleaning Interval while achieving acceptable CRES.

- If CRES is stable, increase Cleaning Interval by 10 DUT touchdowns. When CRES increases, repeat previous Interval, and recheck. If CRES is acceptable, then run additional samples to verify performance.
- If CRES is too high, decrease Cleaning Interval by 10 DUT touchdowns, and recheck. If CRES is acceptable, then run additional samples to verify performance.

Troubleshooting

Troubleshooting your cleaning process depends on the device yield, and the type and amount of contamination found.

After setting the initial parameters, allow the system to run for a period, perhaps 10 probing/cleaning cycles. When you have collected enough data to spot trends, review the device yield.

- If the yield decreases over time, varies cyclically with the cleaning interval, or is lower than expected, refer to the table below to increase the cleaning efficiency.
- If the yield is stable and acceptable, consider reducing the cleaning touchdowns per cycle or increasing the interval between cleanings to verify the settings and optimize the process.

Issue	Possible Actions
Contamination on tips: • Metal • Organic • Oxide • Or yield does not recover after cleaning	• Run cleaning cycle 1 or 2 times (200-500 touchdowns) • Check probe tip height Oxide • Check cleaning media height and planarity • Check XY step between cleaning touchdowns • Visually inspect probe marks on cleaning media • Increase cleaning overtravel if contamination limited to some areas of probe • Increase touchdowns per cleaning • Decrease cleaning interval • Monitor yield closely
Yield drops off between cleanings	• Decrease cleaning interval • Double Z touchdown
Particles around the tips	• Offline brush clean • Reduce cleaning overtravel • Replace cleaning media • Change to a different type of cleaning media
Abrasion on membrane (see figure "Lapping film abrasion on membrane" on page 10)	• Reduce cleaning overtravel • Check probe tip height • Check cleaning medium height and planarity
Repeating indents on probe face (see figure "Repeating particle indent, near miss"	• Replace cleaning media
None	• Return to service • Increase cleaning interval • Reduce touchdowns per cleaning

Offline Cleaning Methods

Brush Cleaning

Refer to the section of this document dealing with Offline Cleaning for instructions on cleaning Pyramid Cores with a brush.

Abrasive Cleaning

CAUTION
Offline abrasive cleaning can reduce the lifetime of your Pyramid Probe card. Use this procedure only after other possibilities have been exhausted.

Extreme resistive buildup contamination can be removed by abrasively cleaning the probe tips. This cleaning process is identical to the online process described above, except that the number of touchdowns is higher.

In most cases resistive tips can be cleaned up with only 200-500 touchdowns on the cleaning film. However, sometimes more aggressive cleaning is required. In these instances, up to 1000 touchdowns may be necessary to remove the contamination. Accumulation of contamination this tenacious usually indicates other problems in the probing environment. High current, residue on bond pads, insufficient online cleaning, and hot probing (making or breaking contact with power applied) can all contribute to abnormal accumulation of resistive films on Pyramid Probe tips.

Service

To remove the most severe contamination, return the probe card to FormFactor for cleaning. Before shipping a part to FormFactor, obtain a Return Material Authorization number (RMA #). Contact your local Field Applications Engineer or Account Manager for assistance.