ArcadiaTest

Test Fixture Manufacturing

Preventative Maintenance Recommendations

For

In Circuit Test Fixtures and Test Probes

OVERVIEW

Test probes can be expected to provide reasonable life expectancy, minimum downtime, at little cost if properly maintained. Our customers frequently ask what procedure we recommend for preventative maintenance of our test probes. The necessary frequency and method of the maintenance/cleaning of our probes depends upon a variety of factors. One must consider the working environment, the type of fixture involved, the probe tip style selection, spring force, contamination levels, and more. While we have given some guidelines in this manual, each customer should use their own discretion in determining what is best under their circumstances.


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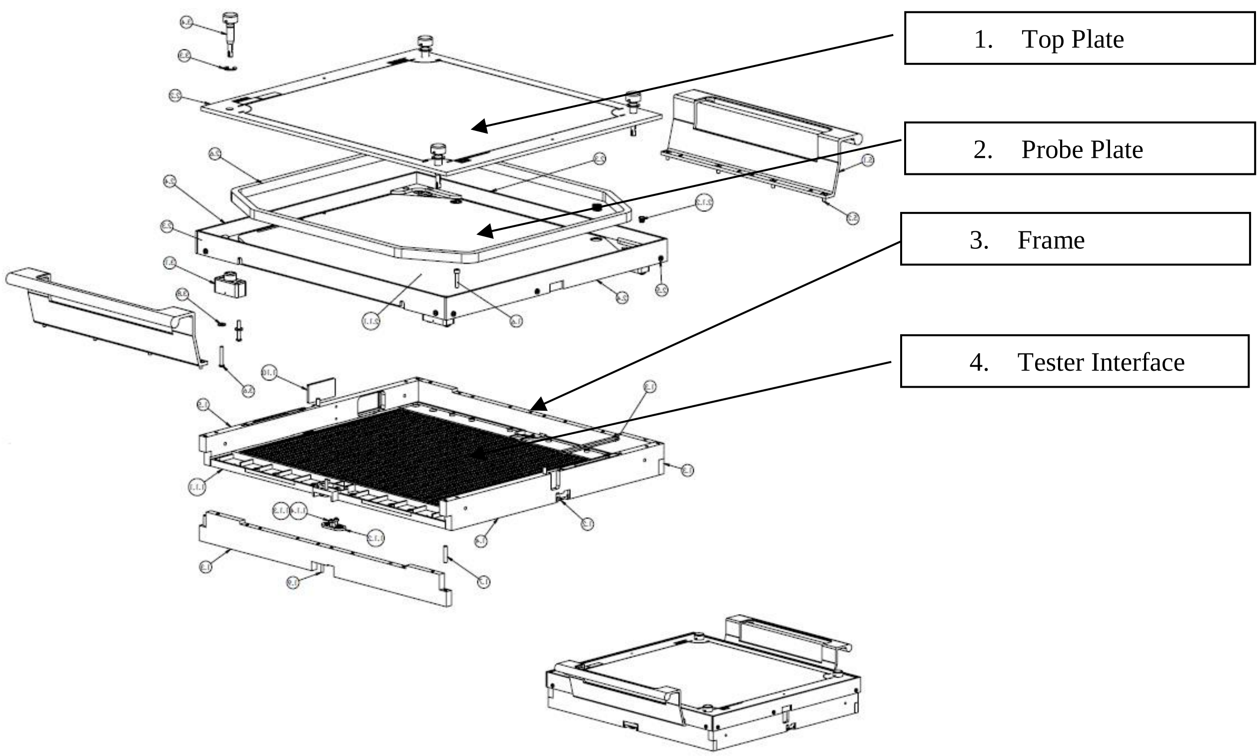
PCBA TEST FIXTURE TYPES

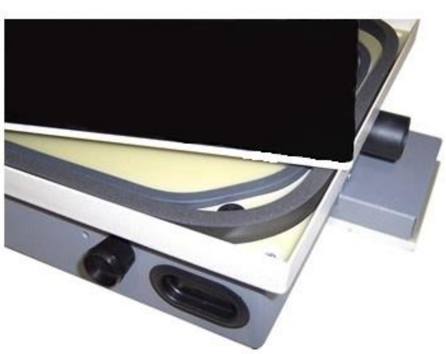
- In-Circuit Test – Vacuum or Pneumatic
- Rack Functional – Vacuum, Pneumatic, or Mechanical
- Bench – Vacuum, Pneumatic, or Mechanical

TYPICAL PCBA TEST FIXTURE COMPONENTS

A typical PCBA fixture kit consists of 4 basic elements:



VACUUM ACTUATED TEST FIXTURES



A **standard vacuum fixture** operates by evacuation of air from inside the bellows area of the fixture. Generally a gasket is used to seal the perimeter of a PCB and the total area volume of air which must be evacuated is the area inside the internal gasket plus the area underneath the PCB.

In the case of an **iso-vac fixture**, which features a mechanical hold down gate, the area to be evacuated is outside the internal gasket between the top plate, and probe plate.

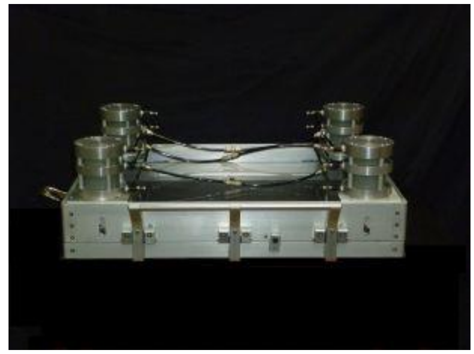
If a **vacuum box fixture** design is used, you will need to calculate the additional volume and flow required to evacuate the vacuum box in addition to other areas of the fixture.

MECHANICALLY ACTUATED TEST FIXTURES

Mechanically actuated fixtures offer an ideal solution for low-mid volume applications when the added expense of adding forced-air or vacuum systems is not practical. Mechanically actuated hold down gates are ergonomic, reliable, and cost effective for benchtop characterization, functional test, or in-circuit test applications.

PNEUMATICALLY ACTUATED TEST FIXTURES

Pneumatically actuated hold down gates operate on a similar architecture as mechanical hold down gates except with the added benefit of hands-free pneumatic actuation.



ICT FIXTURE RECEIVERS

AGILENT 307X “SHORT WIRE” RECEIVERS

(Receiver) Interface Pins

There are many ICT ATE system designs which utilize Pogo® pins for contacting the interface portion of the test fixture. The use of high quality test probes, combined with regular effective maintenance is highly recommended to alleviate intermittent contact issues.

TEST PROBE SELECTION

As a guideline, spring probe selection is facility dependent. The explanation for this, is that, every manufacturing site has its own unique variables such as environment, types and consistencies of flux residue, vacuum system etc., all of which can effect probe performance. Even with considering all the potential variables, there are some general spring probe guidelines that can be recommended.

First re-evaluate the tip style of probes currently being specified. In a no-clean process the flux residue hardens and forms a barrier between the test point and probe. Therefore, plunger tips must be selected that are designed to be more aggressive, logically sharper is better.

However, if testing vias, a broad blade may provide more effective contact.

Selecting a proper material and plating is important. Consider the following contemporary materials:

1. Standard beryllium copper (BeCu) probe plungers offer a the most cost effective solution to PCB's. However, tip wear may be accelerated at high forces, or from other factors. BeCu also offers unsurpassed conductivity and should be used when the highest yield rates are desired.

2. Steel probe plungers offer the increased ability to penetrate flux residue at higher forces for longer periods as the material is harder than BeCu. The steel tips stay sharper longer and can improve your test results without having to increase the spring force of the probe.

When probe contact problems occur, a natural assumption is to automatically increase the spring force of the probe in a fixture. There are pros and cons to choosing to increase probe spring force. The positive result from deciding to increase spring force, is that it will increase the probability of penetrating the contaminants on the circuit card. On the negative side the high spring force can cause sealing problems between the UUT and fixture. Many vacuum systems may not be adequate to accommodate the extra force now required to pull down the board. This problem can lead to unacceptable test yields and long test time due to poor probe travel and operator fatigue from pushing on the UUT/

The bottom line with probe selections is that it is best to have several options. Through experimentation user's will be able to select the appropriate probe for a given application. One that provides optimum performance while satisfying the economic goals of the company.

MAINTENANCE & CLEANING

The test environment is a large contributor to probe contamination due to flux coated test points on the PCB, nearby wave soldering machines, or even shop floor dust and dirt. In order to maximize the life of your probes we recommend following the guidelines and cleaning procedures listed below.

Guidelines:

- Utilize dust covers. Their use will prevent air-born contaminants from settling on probe tips. This is especially important in the case of vacuum fixtures. Dust that settles on the board test area can be easily drawn directly onto the probes when the fixture is put into use.

- Proper probe maintenance can ultimately save time and money at the production level. Reliable testing reduces the chance of false failures and added rework expense.

Test Probe Cleaning Procedure:

The use of solvents is not recommended, as the solvent can damage vital component lubrication.

Recommended Method:

1. To clean probe tips of dust, lint, flux and other contaminants, gently brush the tips with a brass, or nylon, bristle brush.
2. It is best to brush in both X and Y directions, as well as opposing diagonal directions to assure complete coverage and maximum contamination and debris removal.
3. Use pressurized air or vacuum to remove loose debris or contaminants.

If you have any questions, or if we can be of assistance to you in recommending the best maintenance procedure for your circumstances, please do not hesitate to contact your local sales representative.

PREVENTATIVE MAINTENANCE

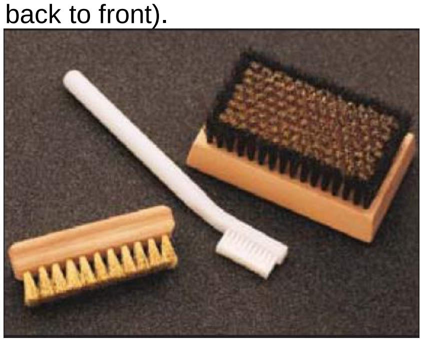
A test fixture is a precision measuring device that requires preventative maintenance to perform consistently at optimum levels. Preventative maintenance falls into two (2) categories: Daily P.M. and a Major P.M.. Daily P.M. requires 10 - 15 minutes of time and is crucial to maximize productivity. A Major P.M. may take several hours to complete depending on fixture complexity and probe count.

Establishing a routine P.M. cycle insures the longevity of your test fixture. Below are recommendations for your P.M. program.

Daily P.M.:

1. Use vacuum or forced air to remove debris and contaminants from the surface of the top plate and the entire fixture. If the fixture includes a Hold Down Gate apparatus, open, and vacuum the exposed UUT area inside of the gate assembly.

2. Remove the top plate or stripper plate and brush the probe field. We suggest using long strokes across the probe field moving only one direction at a time. Starting from the left to right, brush completely across the top of the probe field with one long, gentle stroke. Perform this motion three (3) times across the entire field. Repeat this routine in the three remaining directions (right to left, front to back, back to front).



3. Vacuum the surface or use forced air again around the probe field to remove the contaminants and debris dislodged during brushing.

4. Before replacing the top plate or stripper plate, be sure that all tooling pins, alignment pins, or linear bearings have not come loose, and are in good working condition.

5. If the fixture is equipped with Vectorless Test, or other specialty products, such as RF probes, take care not to damage any transfer cables or sensors, and ensure they are seated properly and that none are damaged after performing maintenance.

Major P.M.s:

The following are general recommendations and can be followed at the onset of a fixture maintenance program and should be continued unless experimentation reveals a more appropriate schedule.

30K Cycles

- Replace all probes
- Use vacuum or forced air to remove debris and contaminants.

80K Cycles

- Inspect or replace all counter force springs.

100K Cycles

- Replace probes if necessary
- Inspect and repair any missing, damaged, or worn parts during all PMs (tooling pins, push fingers, etc.).

REQUIRED TOOLS and SPARE PARTS

Probe maintenance and repair within most test fixtures becomes a difficult and time consuming task when the appropriate tools to perform this task are not on hand. We suggest the following items be made readily available for use by all engineering and maintenance personnel:

HAND TOOLS

- 1 Small Ball Peen Hammer
- 1 Complete Set of American Standard Allen Wrenches
- 1 Set of Small Nut Drivers
- 1 Pair of Needle Nose Pliers
- 1 Pair of Standard Pliers
- 1 Pair of Jewelers Pliers
- 1 ea. Small, Medium, and Large Slot Head Screw Driver
- 1 ea. Small, Medium, and Large Phillips Head Screw Driver
- 1 Small Adjustable Wrench
- 1 Small Set of Flat Punches
- 1 Electric Screw Driver with a Battery Charger and Spare Batteries
- 1 Pair of Multigage Wire Strippers
- 1 ea. Exacto Knife with both Flat and Pointed Blades
- 1 Handheld Pin Vise

TOOLS AND SPARE PARTS Cont.

- Probe Insertion Tools for 100 mil, 50 mil, and 75 mil Centers
- 1 ea. 100 mil Probe Insertion/Extraction Tool
- 1 ea. 100 mil Adjustable Receptacle Setting Tool
- 1 ea. 75 mil Adjustable Receptacle Setting Tool
- 1 ea. 50 mil Adjustable Receptacle Setting Tool
- Torrington Pins for 50, 75, and 100 mil Receptacles
- 1 ea. 28awg and 30awg Wire Wrap Tool
- 1 ea. Wire Unwrap Tool
- 1 ea. Probe Cleaning Brush
- 1 ea. Fastite Insertion Tool
- Loctite 416 and 420 adhesive and accelerator
- ((3070 Only) 1 bag (100 ea.) Spare Personality Pins
- (3070 Only) 1 ea. Personality Pin Setting Tool

In addition to these items, it is critical to have an ample supply of spare probes and receptacles. It is advisable to stock enough probes to perform a complete probe replacement on two average point count fixtures and , generally, 100 ea. receptacles of each type normally used is sufficient to handle daily repairs and maintenance.

PROBE TRAVEL MEASUREMENT

Procedure:

1. Remove the fixture top plate. Using a pair of digital calipers, measure the height of the fixture pin field (this is the distance between the tip of a normal probe and the top of the fixture probe plate). Lock the calipers at this measurement and without closing the calipers, reset "0" on the digital display.

2. Select and remove a probe from a receptacle and replace with an identical probe that has been glued fully compressed using Loctite. This probe should be "lightly" set into the receptacle so as to be even in height to the fixture pin field.

3. Using the appropriate UUT, actuate the fixture. This will force the fully traveled probe to be set lower than the remaining pin field.

4. Remove the fixture top plate.

5. Return to the probe location being measured and measure the distance from the tip of the now compressed probe, to the top of the fixture base plate. DO NOT PRESS TOO HARD OR SET THE PROBE DEEPER INTO THE RECEPTACLE AS THIS WILL GIVE YOU INACCURATE RESULTS.

6. The digital display on the calipers will give you actual probe travel. Optimum probe travel is 2/3 of full travel (i.e.: .167 for .250 stroke probe).

7. Repeat this procedure and record measurements for the four corners and center of the UUT.

COUNTER FORCE THEORY

Vacuum Test Fixtures

In standard vacuum fixtures, counter force springs are uniformly and strategically installed in “spring pockets” at various locations between the top plate and probe plate to balance the opposing forces of spring probes vs. vacuum. This slows the top plate down during fixture actuation allowing time for the UUT to seal against the molded gasket.

If a fixture is having sealing or contact problems due to changes in atmospheric pressure or other issues, or if you install higher spring force probes, it may be necessary to adjust the fixture counter force to match the test environment.

Whenever making any counter force adjustments, please consider the following:

- Too little counter force within a fixture can result in:
  - UUT sealing problems.
  - Top plate popping due to probes forcing premature vacuum seal breaks on fixture de-activation.
  - Boards that catch on the tooling pins during fixture evacuation.
- Too much counter force in a fixture will result in top plate movement being too slow and/or poor probe travel. Proper fixture actuation is critical in no clean environments!
- It is not feasible for your fixture vendor to duplicate all test environments. However, they may offer to simulate your test environment by testing the fixture’s vacuum seal by adjusting their system settings to your specific XX”hg @ X cfm.

It is important to note that UUTs that have a high density of probes per square inch of PCB area may require more vacuum force. Generally, vacuum requirements start to become more critical if the average probe loading of your UUT exceeds about 10 probes per square inch of PCB area. Also, if your UUT has openings that can't be sealed with a gasket (e.g., open vias or routes), or if it has unsoldered through-holes, it may require more vacuum CFM capacity to overcome leakage.

RECEPTACLE REPLACEMENT

During production or maintenance, damage may occur to test probe or socket locations. Receptacle replacement is a difficult and time consuming process, however, with the proper tools and patience, it may be possible to repair the affected location(s) on-site and resume production in a minimum amount of time.

<u>Procedure:</u>

Note: For multiple receptacles, it is advisable to perform repairs one at a time in order to avoid inadvertently swapping wires.

1. Remove fixture top plate to access damaged receptacle. Remove probe with needle nose pliers if possible.

2. Open the fixture base for access to the wired end of the receptacle.

3. Using a wire unwrap tool, remove signal wire from wire wrap tail of damaged receptacle.

4. Turn the fixture to access the probe end of the damaged receptacle.

5. Select the appropriate Receptacle Insertion Tool.

6. Insert the Receptacle Insertion Tool into the receptacle completely and using a hammer or mallet, drive the damaged receptacle completely through the base plate and out the bottom of the fixture.

7. Remove a probe in another part of the pin field that matches the size and style of the receptacle/probe set being replaced. This empty receptacle can now be used for height adjustment of the Receptacle Insertion Tool.

8. Insert the Receptacle Insertion Tool completely into the empty receptacle until it bottoms out.

9. Insert the replacement receptacle into the previously removed receptacle location. Take care to insert tool vertically so as not to bend or damage the receptacle.

10. Using the Receptacle Insertion Tool, set the receptacle into the base plate by tapping it with a small hammer or mallet. Carefully remove tool by extracting vertically. Removing the tool at an angle can result in damage to the receptacle and/or tool.

11. Install a new probe into the replacement receptacle.

12. Using the appropriate wire wrap tool or gun, re-wrap the signal wire onto the tail of the replacement receptacle. Whenever possible, strip a clean portion of wire for re-wrapping.

13. Be sure to clear the inside of the fixture of any debris left behind by this process. Re-assemble fixture.

BROKEN PROBE BARREL REMOVAL

During production or maintenance, damage may occur to a test probe(s) which results in the entire plunger being broken with little or no section of the plunger or barrel available to grasp for removal.

As with receptacle replacement, barrel removal is an art. With proper tools and patience, it may be possible to remove a broken probe barrel to pair the affected location(s).

Procedure:

Open the fixture and remove the stripper plate to access the probe field and proceed with the following method:

1. Locate the damaged probe. Remove the probe barrel with needle nose pliers if possible. If that does not work, proceed to step #2.

2. Utilizing a hand held pin vise, with the appropriate drill bit installed, slowly screw the drill bit into the barrel, rotating the pin vise clockwise, using firm pressure. Continue screwing the drill bit into the barrel until an insertion depth of approximately ¼" – ½" is reached.

   Pin vise part numbers and recommended drill bits are identified below:

McMaster –Carr (www.mcmaster.com)

Item	Part Number	Description
Pin Vise	8455A12	Double End Pin Vise, 0-.125" Size Range
50 mil Drill Point	30585A91	Drill Bit, Wire Ga 73,1-1/8"oal,0.3" Drill Depth,118deg
75 mil Drill Point	30585A86	Drill Bit, Wire Ga 69,1-3/8"oal,0.5" Drill Depth,118deg
100 mil Drill Point	30585A73	Drill Bit, Wire Ga 57,1-3/4"oal,0.7" Drill Depth,118deg

3. Once the drill bit is inserted into the probe barrel firmly pull directly upwards to extract the probe barrel. Note that this procedure relies on the drill bit to engage the roll-close are of a test probe barrel effectively. If the roll close is sufficiently damaged or becomes "drilled out" during this procedure, it may not be possible for the drill bit to engage the probe barrel sufficiently to allow extraction.

   If steps 1-3 do not result in a successful barrel extraction, consider utilizing the next procedure.

PROCEDURE #2

This procedure is quite effective but requires additional tools and extreme skill and care when utilized.

1. Locate the damaged probe. If necessary, remove any remaining damaged components (plunger, spring, bias ball, etc).

2. Use a new, or used probe, insert the plunger deeply into the damaged probe barrel. If the broker plunger is left inside the barrel, this may require a higher force probe to work effectively. Take care not to break the probe plunger being used for extraction. Alternatively, utilize an appropriate length of stripped wire and insert it deeply into the probe barrel.

3. Using a standard soldering iron to the wire or probe plunger, apply solder until a reasonable amount has flowed into the broken probe barrel.

4. Remove the soldering iron and allow the solder to cool. This will fasten the probe plunger, or wire, inside the broken probe barrel in the test fixture.

5. Once sufficiently cooled, simply pull the probe or wire to extract the damaged probe plunger.

VACUUM SYSTEM CONSIDERATIONS

A factor that is easily overlooked in the test department is the vacuum system. A well designed vacuum system that allows a fixture to be activated as quickly as possible will provide tangible benefits in the ATE environment. The reason for this is that a vacuum fixture, which snaps down when activated, enables the spring probes to penetrate the flux residue on a PCBA more effectively. The expression “vacuum system” is intended to be a global term referring to the vacuum pump and plumbing network linking it to the tester and fixture.

Most ATE test heads will require about 20” – 26” inches of mercury (approximately 67.75 kPa) with a 5-20 gallon vacuum surge tank (vacuum reservoir) either internal to the tester, or inline very near to the ATE system to work properly. Properly sized vacuum surge capability accommodates the initial vacuum requirement when activating the fixture repeatedly. Certain ATE systems, such as Teradyne (Genrad, Zehntel), will likely have vacuum surge tanks built into the system. Agilent (HP) 3070’s generally will not. While integral surge tanks provide some capacity, additional surge capability may be added by adding an external surge tank, or by increasing the size of the vacuum supply lines. For example, more robust vacuum systems will use 4” pipe to run to their systems. The increased area within the pipes serves effectively as a surge tank with such a wide diameter of pipe introducing vacuum to the system.

We recommends that a minimum of 25 inches of mercury and 40 CFM be available for each test system in operation at all times. Pumps with this capacity are generally 1.5 HP and larger and use 3-phase power.

In general, it is wise to purchase a larger pump than you need. Any additional cost of purchasing a larger pump is relatively small. If you add ATE systems in the future and want to share a pump, or if you have a problem UUT requiring additional capacity, you will be prepared.

A poorly designed plumbing layout can cause restrictions in air flow from the pump to the test fixture. By definition, restrictions are created by the diameter and shapes of pipes, and are bad for fixture performance. For instance, a 90 degree elbow is a restriction, for that reason it is recommended that all openings and inlet parts have rounded , curved maximum diameter openings . The diameter of the pipe servicing the fixture should be as large as possible with 2 inches being the suggested minimum diameter.

Valves with openings of 1/4” to 3/8” should be replaced with either 3/4” or 1” valves. At the same time smooth angled reducer fittings should be used in lieu of abrupt angled variations.

Other Vacuum System Considerations

- The vacuum hose connected from the vacuum system to the tester should be large enough not to restrict flow and quickly and completely pull the board down on the spring probes rapidly.
- A vacuum release valve may be required in the tester in order for a vacuum fixture to quickly and easily release at the end of the test cycle. If the release is flow is inadequate, most fixture suppliers offer touch release features which can be integrated into the fixture to expedite release for improved throughput.
- When implementing a manifold system be sure to keep the lines as equal length as possible to equalize surge capacity and CFM flow rates.

Many ATE system users employ a vacuum gauge as the sole measurement tool for determining how efficient the vacuum system is operating. Both operation pressure (inches of mercury), and available volume (CFM), should be monitored. One without the other can cause the vacuum system to be ineffective.

In summary, more vacuum is better. The entire vacuum system must be evaluated and upgraded to accommodate the harsh no-clean manufacturing environment. The user’s goal should be to maximize the volume of air delivered to each fixture. A global vacuum system designed to consistently deliver 25 inches of mercury at 40 CFM will, in the long run, reduce test time and improve test yields.

VACUUM SEALING INTEGRITY OF THE FIXTURE/PCB

Two important components of test that are easily overlooked are the actual design of the fixture and PCB, itself. Inevitably elements of the PCB design can impact the performance of a fixture. Specifically, it should be specified that all bare board vendors must seal all unused vias. In addition vias used for test points should be soldered. If a board has quantities of open vias at the in-circuit test level it will undoubtedly prohibit using vacuum directly under the board. The test fixture would then require a hold down gate increasing the cost of a fixture and potentially reducing the throughput rate. Another element of PCB design that can negatively impact the testability of a board is the distribution of test points. By avoiding high concentrations of probes in areas of the fixture you will achieve a better vacuum seal. The allowance for capped vias and distributed test points will improve the ability of the fixture to obtain an initial seal of the UUT, which correlates to a quicker more efficient actuation of the fixture.

MATERIAL STORAGE

Gasket Material

The shelf life of gasket materials will vary and largely depends upon the environment in which they are stored.

Avoid exposure to elements such as ultraviolet rays, high temperatures, and elevated moisture or humidity that can have an adverse effect on the overall storage life of the material.

It is recommended that gasket materials be stored at the following conditions:

- Temperature range between 60-80qF (15-27qC)
- Humidity range between 40-50%
- No direct exposure to sunlight

Properly stored gasket materials generally have long shelf lives. Assuming storage at the recommended conditions, The general recommendation is a three-year shelf life from the date of manufacture.

It is not always possible to ascertain that proper storage conditions have been maintained over an extended period of time. If proper records have not been maintained, it recommended that customers test materials that have been stored to ensure that they are suitable for the intended use.

Gaskets often show little or no loss of their original properties well past three years. However, good practice requires that steps such as dating and rotating inventory be used to help ensure that the materials are put into use as quickly as possible. These recommendations deal only with gasket materials in roll form; conditions may vary once the material has been altered in any way, such as being cut or laminated.

On occasion gasket materials will not be used within the recommended shelf life and may or may not undergo degradation or loss of product quality in these situations, depending on, among other things, storage conditions.

Other related materials such as adhesives, have their own, and possibly shorter, shelf lives.

CONCLUSION

The manufacturing process is a challenge to every test department but it doesn't have to be difficult.

By initially working with the PCB designers for proper design for test, and then implementing the suggested recommendations above, one can expect excellent test integrity and yields. Where users get into trouble is when they wait too long to integrate proper maintenance discipline. By waiting, users are put into an emergency reactive mode, which is costly and ineffective. Therefore, the key to successfully testing printed circuit boards is to be proactive in determining the most effective strategy for testing and maintaining the test hardware, well in advance of the starting production.

For additional assistance or to get spare parts and tools for your Test Fixture please contact us at:

ArcadiaTest

Test Fixture Manufacturing

101 Hammond Ave
Fremont CA 94539
408-855-8268
sales@arcadiatest.com

Please reach out to any of our team below if you have any questions or need any assistance.

For Spare Parts – sales@arcadiatest.com

John McCormick john@arcadiatest.com – Director of Sales

Jesse Rogers jesse@arcadiatest.com – Sales Engineer – North America

Robert Foley robert@arcadiatest.com – Global Field Service Manager

Israel Zavala israel@arcadiatest.com – Mexico Field Service - Sales