# CheckSum Fixture FAQs

## Frequently Asked Questions about Test Fixtures

In working with our customers, we have found there are some common questions about bed-of-nails fixturing and test systems. Here are some general guidelines to consider when planning for your test fixture. If you have any questions, call us at 1.877.CHECKSUM or +1.360.435.5510, we would be happy to discuss your testing needs. Be sure to ask to expedite your job for a faster turnaround.

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## Bed of Nails Basics

### Q. How do "bed-of-nails" fixtures work?

On a bed-of-nails "fixture" or "test head", the unit-under-test (UUT) is forced onto a number of spring probes ("nails") that are electrically connected to the test system. The test system can then make measurements between these points.

### Q. How is the UUT forced onto the nails?

On pneumatic test fixtures, such as the CheckSum Analyst, TR-9 and TR-7 series, compressed air pressure and pressure/push rods are used to press the UUT onto the spring probes. On vacuum fixtures, such as CheckSum's Model TR-3 series, vacuum is used to pull the UUT down onto the probes. On mechanical test fixtures, such as CheckSum's Model TR-5, the operator presses the UUT down onto the probes via the force of closing the top cover, with pressure/push rods, down on the UUT.

### Q. What are the major elements of mechanical, vacuum, and pneumatic fixture systems?

On the TR-5 mechanical fixture, the entire fixture is dedicated for a UUT. The test point electronics from the test system plug into the back of the fixture. On the TR-5-400 / TR-5-600 mechanical-advantage, TR-3 series vacuum, and Analyst / TR-9 / TR-7 pneumatic fixtures systems, there is a fixture receiver (or press) which is shared by all of your UUTs, then a customized "fixture" (or "test head") is built for each different UUT. The customized test head in the fixture receiver or press is easily changed.

### Q. How do I choose between vacuum, pneumatic and mechanical fixtures?

Pure mechanical fixture systems work well on smaller UUTs (up to about 150 test points) to minimize cost.

Mechanical-advantage fixture systems can be used up to about 600 points.

Pneumatic fixtures are efficiently used for most fixturing applications up to about 3000 points.

Vacuum fixtures are appropriate in applications when maximum top access is necessary or when loading/unloading time must be minimized.

Pneumatic and mechanical fixtures can sometimes be used where vacuum cannot, such as with very dense probe loading or UUTs with open vias or complex routing.

For customers concerned about board flex or strain, pneumatic fixtures are a better choice.

## Customizing the Fixture

### Q. How big a board can I put on a test fixture?

The various size guidelines are shown below. Slightly larger boards may also fit, depending on where the test probes must be positioned with respect to the UUT.

#### 12KN Dual Level Guidelines

KIT28, KIT20, KIT2KN-QC or KIT1000-QC Fixtures
Assembly size can be up to (approximately) 24 x 13.2 inches (61 cm x 33.5 cm), dual or single-sided probes and TestJet.

#### TR-9-2000-QC Guidelines

KIT2KN-QC or KIT1000-QC Fixtures
Assembly size can be up to (approximately) 16 x 13.2 inches (40.6 cm x 33.5 cm), dual or single-sided probes and TestJet.

#### TR-9-1000-QC Guidelines

KIT1000-QC Fixtures
Assembly size can be up to (approximately) 16 x 13.2 inches (40.6 cm x 33.5 cm), dual or single-sided probes and TestJet.

#### TR-7 Series Guidelines

KIT1000-QC, KIT2000-QC or KIT3000-QC Fixtures
Assembly size can be up to (approximately) 16 x 13.2 inches (40.6 cm x 33.5 cm), dual or single-sided probes and TestJet.

#### TR-5-400-QC and TR-5-600-QC Guidelines

KIT600-QC Fixture Guidelines
Assembly size can be up to (approximately) 11.75 x 8.5 inches (30 cm x 21.5 cm), dual or single-sided probes and TestJet.

### TR-5-812 Fixture Kit Guidelines

The kit is 8 x 12 inches (20.3 cm x 30.5 cm) overall and can accommodate an assembly size up to (approximately) 6 x 6 inches (15.24 cm x 15.24 cm) with bottom-side probes only.

### TR-5-1216 Fixture Kit Guidelines

The kit is 12 x 16 inches (30.5 cm x 40.6 cm) overall and can accommodate an assembly size up to (approximately) 10 x 10 inches (25.5 cm x 25.4 cm) with bottom-side probes only.

### TR-5-1620 Fixture Kit Guidelines

The kit is 16 x 20 inches (40.6 cm x 50.8 cm) overall and accommodates UUT sizes up to 14 x 14 inches (35.5 cm x 35.5 cm) with bottom-side probes only.

### TR-5-1612-C Fixture Kit Guidelines

The kit is 16 x 12 inches (40.6 cm x 30.5 cm) overall and accommodates UUT sizes of up to 13.5 x 8.5 inches (34.3 cm x 21.6 cm), dual or single-sided probes and TestJet.

### TR-3-2024 Fixture Kit Guidelines

Assembly size can be up to (approximately) 21 x 17 inches (53.3 cm x 43.1 cm), single-sided probes and dual or single-sided TestJet. Smaller vacuum fixture kits are available for smaller boards.

## Q. What is involved with customizing the test head for a particular assembly that I want to test?

There are several steps. You start with a mechanical fixture kit (e.g., CheckSum's Model TR-5-1216), a pneumatic fixture kit (e.g., CheckSum's Model KIT1000-QC) or a vacuum test head kit (e.g., CheckSum's Model TR-3-1620), then the steps below are done:

Probe placement is determined. A probe is generally placed on each network. The layout is usually done automatically, working with CAD data. Probe placement can be manually determined, (only on through-hole technology PCB's) but is more expensive, has a longer lead time for the project, and is less accurate.

The fixture is drilled to match the pads on the UUT. Generally, only the test points are drilled.

Guide pins are made and installed to accurately position the UUT. These pins typically utilize tooling holes on the UUT. To review the PDF document **PCB Design Guidelines for In-Circuit Test**, see http://www.checksum.com/PDFs/PCB_Design_Guidelines_for_ICT.pdf

Pressure rods, which will apply top pressure to the UUT for mechanical/pneumatic fixtures, are positioned for the UUT. Holes are drilled in the top pressure plate for the pressure rods. For vacuum fixturing, a gasket is constructed and installed around the edges of the UUT and under any UUT openings where vacuum leaks can occur.

Spring probes and receptacles are installed at the desired test points.

Wiring is done by wire-wrapping from the bottom of the spring probe receptacles to the interface connectors of the fixture.

Proper fixture operation and wiring is verified.

## Q. Does the customized part of the fixture have to be done by CheckSum?

No, there are many fixture vendors. See the list of test fixture vendors at the end of the FAQs.

### Q. Can I build my own fixtures?

With the proper equipment (e.g., a way to accurately do the drilling), fixtures can be built by the end-user. However, it does require special expertise in many cases to solve some of the problems that can occur. For that reason we recommend that you have at least one fixture built by specialists to serve as an example. You can also contract some of the job, like drilling, then do the wiring yourself.

### Q. To test my board, how many probes are required?

Generally, one probe is used for each electrical network (node). As a result, there will be many less probes than there are holes in the board; the node-count is generally about a third of the hole-count. Optionally, you can install extra probes to power supply networks and to very low-impedance value components to help facilitate external sensing of measurements for highest accuracy.

If you want to confirm open connections in PCBs, you will need to use more than one probe per network. This is seldom done in practice since most PCBs are tested prior to assembly and opens typically aren't caused during the assembly process.

### Q. What kind of spring probes should I use?

There are many styles of probes available; many with special attributes for particular applications. The most commonly used probes are some variation of a crown style or chisel style with contact forces of about 6-10 ounces per probe.

Consult the spring probe manufacturers for recommendations on head style and spring force.

See the list of spring probe vendors at the end of the FAQs.

### Q. Is there anything special to tell a fixturing facility about how to wire a CheckSum test head?

Make sure that they have a copy of CheckSum's wiring conventions (block and connector nomenclature and pin numbering scheme). We will provide this information directly to the vendor if you wish. For GenRad-style vacuum fixtures, the test head is oriented with the interface towards the operator, so the UUT orientation is generally reversed from GenRad fixtures.

If you are fixturing for functional test, there are some special wiring considerations. See the Model FUNC-2 Instruction Manual for details.

### Q. How large must the vacuum test head be?

The outside dimensions of the test head need to be at least 3 inches (7.6 cm) larger than the UUT (1.5 inches, 3.8 cm, all around). The most popular sized vacuum test head that CheckSum sells is the TR-3-1620, 16 x 20 inches (40.6 cm x 50.8 cm) overall. Both smaller and larger test heads are available. CheckSum lists the sizes of our test heads in overall size. Some other manufacturers list the working area. Make sure to ask the supplier if there is any question about their dimension conventions.

### Q. I need a small amount of special circuitry to help test my UUT. Can this be accommodated?

There is sufficient room in most test heads to accommodate internal circuits like relays or breadboards. CheckSum offers the Model TR-6-2 Interface Module especially designed for this use.

### Q. I will be testing surface-mount boards. Can they be used with a bed-of-nails fixture?

For the lowest cost fixture, lay out the PCB so that there is access from one side of PCB to at least one point on every network (net). Careful placement of through-holes can usually provide this. With this layout, you can test using a standard test head. Recommended target pad size is .035 inches (0.89mm) or larger. If you require probe access to both sides, special double-sided fixtures can be built. Double-sided fixtures are very common with SMT boards however they are more expensive. See the following reference at the SMTA web site for DFT guidelines:
http://www.smta.org/store/book_detail.cfm?BOOK_ID=176

### Q. My UUT has test points on both sides (top and bottom). Can CheckSum probe both sides of my UUT?

CheckSum has been making dual-sided "clamshell" test fixtures for many years. Our pneumatic fixtures and presses are well suited for top probing of fixtures. For top probing, it is important to provide good size test pads for better probing accuracy.

To review the PDF document **PCB Design Guidelines for In-Circuit Test**, see
http://www.checksum.com/PDFs/PCB_Design_Guidelines_for_ICT.pdf

### Q. Are there any other PCB layout considerations?

Fixturing is more reliable and less expensive if holes are on 0.1 inch (2.54 mm), or greater, centers. Probes are available for closer spacing, but the fixturing job is more difficult since closer positioning tolerances are necessary, and the probes are more expensive. The 50-mil and 75-mil probes are very common on the high-density SMT boards we see today. Also, for vacuum fixtures, keep component leads at least 1/8 inch (3.175 mm) from the board edges.

## Providing Air Pressure (Analyst / TR-9 / TR-7)

### Q. What kind of air supply is necessary for pneumatic fixturing?

Standard factory air can be used in most cases. The fixture operates from 80-120 PSI. Use of a standard regulator/filter near the test system is recommended.

Refer to the specific fixture system manual. The higher force spring probes will require greater force to fully-compress. This may require the maximum air pressure; 120 PSI for some test fixtures.

## Providing Vacuum (MultiWriter pps / TR-3 Series)

### Q. How much vacuum do I need?

Most vacuum test heads require about 20 inches of mercury (67.75 kPa) with a 20 gallon vacuum surge tank (vacuum reservoir) to work properly. Pumps with this capacity are generally 1.5 HP and larger.

### Q. Does my particular UUT affect the amount of vacuum needed?

Yes. UUTs that have many 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.

### Q. Does it help to get a bigger pump?

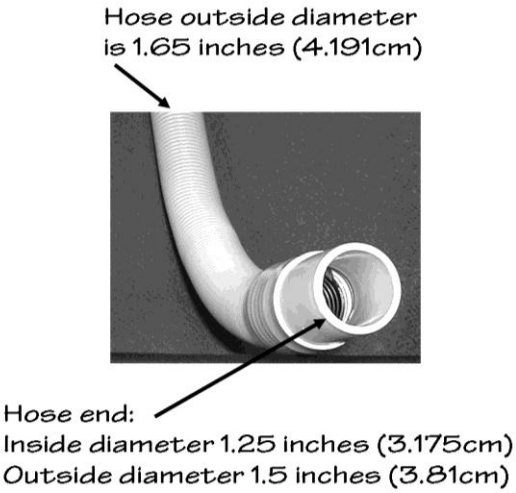
Since the incremental cost of purchasing a larger pump is relatively small, we recommend getting one bigger than you need. That way, if you add systems in the future and want to share a pump, or if you have a problem UUT requiring additional capacity, you will be ready.

### Q. Is a vacuum pump all I need?

You should also have a vacuum surge tank to accommodate the initial vacuum requirement when pulling the UUT down to the fixture.

The vacuum hose connected to the MultiWriter pps or TR-3 series should be large enough to quickly and completely pull the board down on the spring probes.

A vacuum hose picture with additional size details follows:




If the vacuum source is not sufficient, when the vacuum is applied the UUT will not be pulled-down quickly. It needs to be quickly pulled-down to create a vacuum under the UUT to seal the UUT with the gasket. As the UUT moves down, it will compress the spring probes that need to firmly contact the UUT.

### Q. Are there alternatives to the surge tank?

Some facilities use large PVC tubing (e.g., 2 to 3 inches, 5 to 7.6 cm, in diameter) for plumbing the vacuum system. If properly designed, this can effectively serve as a surge tank.

Vacuum surge tanks are generally 10 gallons or larger.

### Q. Can I buy the vacuum pump from CheckSum along with the system?

CheckSum can sell you a vacuum pump along with your system. However, you can save money by buying it directly from the manufacturer. If purchased from CheckSum, we will have the manufacturer ship it directly to you.

### Q. Can you give a recommendation for a vacuum system?

Most ATE systems use Busch brand vacuum pumps. An example of a complete 28 CFM system with motor, pump, tank, filters, hose, skid and casters is the Busch BMV-040-0. A similar 20 CFM system is Busch's model number BMV-025-0. Busch pumps use 3-phase power.

### Q. How much does a vacuum system cost?

For a typical installation, you should plan on about $2500 to $3500 for a vacuum system.

# Miscellaneous Questions

### Q. I've got a bunch of fixtures for my old worn-out system that was made by *%@!#!*%*. Can I use them?

There is nothing unique about CheckSum testers that make fixturing special. If you can adapt your existing fixtures to mate with the 50-pin ribbon cables from the CheckSum System, you're in business. Fixture manufacturers (or CheckSum) can also build adapters from one type of fixture to another type of receiver.

The Analyst fcs (fixture compatible series) is specifically designed to accept Agilent 1, 2 and 4 module 3070 style fixtures. The test system software includes a test program generator to automatically create the CheckSum test program using existing 3070 data files.

### Q. Is there a way to take advantage of the CAD data I have to help with fixturing and programming?

Yes. CheckSum provides CAD conversion capabilities with its in-circuit test systems. Also, third-party software packages can help lay out the fixture and provide an initial test program. Please review our document on the Information Required to Quote and Build Test Fixtures.

### Q. My UUT is not designed for test. Can CheckSum probe on SMT components to improve my test coverage?

Probing on components is a risky practice. The only way to probe SMT parts directly is to probe on the solder fillet. This presents several problems:

1. Solder fillets are not flat, causing the probes to side-load, which will quickly make them unusable.
2. SMT parts often "move" from UUT to UUT making consistent contact a problem.
3. Probing directly on components can damage the component and also can render a poorly soldered component "good" by forcing down a lifted pad.

It is CheckSum's practice not to probe on components. Please review our design for test document.

### Q. I have multi-board panels. Can these be tested before separation?

Yes. They are fixtured just like a single assembly. It you arrange the wiring properly, CheckSum in-circuit test systems allow you to create the test program for the first PCB on the panel, then automatically replicate the test for the remainder of the PCBs. The system also automatically separates test results as appropriate, allows you to skip particular PCBs on the panel, and shows which PCB is being tested.

With panelized PCBs, it is good practice to also provide a single test position to accommodate testing assemblies after separation after they have been repaired.

Please include drawings that show the dimensions for each separate board on the multi-board panel. We need each board's specific XY information to position the spring-probe and guide pin locations.

# Custom test fixtures and test programs from CheckSum

CheckSum can do custom programming and fixturing for you. We recommend that you have us build your first fixture and write the test program used with it to serve as an example and to make sure that you are up and operating right away. Many of our customers continue to have us build their fixtures and write their test programs on an ongoing basis. Call us for a quotation for your next CheckSum fixture project.

## Q. If I am going to have a test head built, what do I need to provide?

You will need to provide complete CAD* information (ASCII full CAD output, Gerber files and a drill file), a mechanical drawing that calls out board dimensions, a schematic, a BOM (Bill of Materials) an assembly drawing showing component placement, a bare-board, and a loaded-board.

To review the **Information Required to Quote and Build Test Fixtures**, see
http://www.checksum.com/PDFs/CheckSum Fixture Requirements.pdf

*Note: Jobs can be processed without full CAD data in some situations, but the costs are much greater and the lead time is increased. If you also provide information directly showing the XY position of each probe and an associated net-list or annotated schematic, it reduces the cost of the job.

## Q. I plan to write the test program, can you give me a budgetary cost estimate for building a custom bed-of-nails fixture for my assembly?

The cost varies, but here is a rough idea of what to expect:

Test fixture kit: $610 - $870
Drilling, file-processing, machining: $750
Wiring connectors: $10 per 50 probes
Probes, sockets, layout, wiring: $3.00 - $6.00 each

Based on this, here is a general idea of what you might expect to pay for mechanical or pneumatic fixtures of various sizes (assuming only 100-mil probes are required):

100 Test points: $1,850
250 Test points: $2,300
500 Test points: $3,500

Vacuum fixturing costs are similar, but higher. With additional vacuum sealing costs and higher fixture kit costs, typical vacuum fixtures are about $1000 more than the alternatives shown.

## Q. If CheckSum is going to write the test program, is there anything else I need to provide?

We need at least 2 or 3 (the more the better) known-good sample assemblies to validate the test program. After programming, we run statistical analysis on all the assemblies to help determine proper test tolerances to accommodate typical UUT-to-UUT and measurement variations. If you have compatible CAD data for the UUT (net list and component values), it can be used to reduce the cost of programming.

### Q. Can you give me a rough idea of how much it will cost to have CheckSum write the in-circuit test programs for my assemblies?

In-circuit test programming charges vary depending on the type of circuitry and node-count. The minimum programming charge is $600 ($300 for Opens/Shorts only).

Here is a general idea of the cost for a complete turn-key test fixture which includes the in-circuit test program for various test point counts:

100 Test points: $2,500
250 Test points: $4,000
500 Test points: $6,000

For panels with duplicate boards the programming cost goes down significantly.

### Q. Does TestJet Technology drastically affect the costs of my fixtures?

Installed TestJet Technology probes cost about $100 per tested component. There usually is an additional fixed charge of about $450 for the top-access assembly that positions the probes. Note that CheckSum's TestJet Technology implementation does not require a multiplexer to be built into every fixture. That is part of the test system.

### Q. What are some of the things that affect fixturing/programming costs?

The type of CAD data you provide: The preferred data is XY locations by component/pin with net names, and an associated net list.

The probe sizes: If close spacing is needed (less than 0.1 inch / 2.54 mm on-center), more expensive 50-mil or 75-mil probes are required.

The nature of the circuitry: Digital boards are the easiest boards to program, with power-analog being the most difficult.

Any special mechanical requirements: Top and bottom probing, side-access, accommodating very large components, and no tooling-hole access can increase fixturing costs.

### Q. Does CheckSum do this work for "time and materials", or can I get a quote?

We do most of our work on fixed-price quotations. To give you a quotation, we need to know the probe-count (available from a net-list), any special probe spacing requirements (usually not a problem on through-hole or designed-for-test SMT boards), the UUT size, and the type of circuitry (digital vs. analog as shown in a schematic). If you provide us with this information we can usually give you a quote within 24 hours.

### Q. How long does it take CheckSum to build a custom test fixture and test program for my UUT?

Standard lead-time is three to four weeks from the time we get your order and UUT materials. We can often do a faster turnaround if you are willing to pay expedite fees.

### Q. Is there anything special about the mechanical design of PCBs that will be bed-of-nails tested?

There are a number of things that you can do to optimize test coverage and fixture reliability while minimizing cost.

To review the PDF document **PCB Design Guidelines for In-Circuit Test**, see http://www.checksum.com/PDFs/PCB_Design_Guidelines_for_ICT.pdf

### Q. Can CheckSum start my job without a loaded assembly?

To insure the fixture matches your assembly, we need a loaded assembly before we start the process. Ask for our paper on Design and Building Custom Test Fixtures for details about what we need for quoting and building your test fixtures. We can provide quotations for fixtures with or without a test program. In some instances, it is possible to get started with a new revision bare board, the most recent revision loaded board, and a list of the affected changes between the revisions. CheckSum will need to review the two (2) boards to determine if the job can be scheduled. You will still need to provide the current revision loaded board by a specified date to have your fixture and test program fully optimized.

## Fixturing Supplier Source List

**CheckSum LLC**
6120 195th St. NE
Arlington, WA 98223
Tel 1.877.CHECKSUM (in the USA) or 360.435.5510

- Complete In-Circuit Test Systems
- Turnkey fixturing and test programming
- Mechanical, pneumatic and vacuum fixture kits
- Fixture receivers

Email: sales.support@checksum.com
Website: www.checksum.com

**CheckSum Europe**
c./Monte Escorial,
5 (locales comerciales)
28200 San Lorenzo de El Escorial
Madrid, Spain
Tel: (+34) 91 890 46 14
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E-mail: CheckSum.Europe@eiit.com
Website: www.eiit.com

**Circuit Check Inc.**

Corporate Headquarters
6550 Wedgwood Road
Maple Grove, MN 55311
Tel: 763.694.4100
Fax: 763.694.4250
Email: email@circuitcheck.com
Website: www.circuitcheck.com

**DeMille Research**

25422 Trabuco Rd., #105-247
Lake Forest, CA 92630
Tel 714.462.9345
E-mail: salesinfo@testsight.com
Website: www.demille.com
* Software for fixture design and board repair

**Derby Associates International**

1 Old Town Square, Suite 300
Fort Collins, CO 80524
Tel +1 970.221.0111
E-mail: sales@derby.com
Website: www.derby.com
* Automated data collection and decision support solutions

**Elektrotek**

1K Unit 3 Eastway Business Park
Ballysimon Road
Limerick, Ireland
Tel: +353 61 431300
Intl: +353 61 431301
Fax: +353 61 431309
E-mail: sales@elektrotek.com
Website: www.elektrotek.com

**Everett Charles Technologies**

Loaded PCB Test Fixture Headquarters
One Fairchild Square
Clifton Park, NY 12065
Tel: 518.877.7042
Fax: 518.877.7052
Email: stongeg@ectinfo.com
Website: www.ectinfo.com

**Landrex Technologies Co., Ltd.**
No.232, Yongchang St.
Yingge Town, Taipei County 239
Taiwan, R.O.C.
TEL: 886-2-26787966
FAX: 886-2-26780160
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Email: ncntechnologies@checksum.com
Website: www.ncntechnologies.com
* Turnkey fixturing and test programming

**Q1 Test Inc.**
780 S. Rochester Ave Suite D
Ontario, CA 91761
Tel: 909.390.9718
Fax: 909.390.9721
Email: sales@q1testinc.com
Website: www.q1testinc.com

**World Test Systems**
215 Fifth St.
Waynesboro, VA 22980
Tel: 540.949.6753
Fax: 540.949.3826
Email: world@worldtest.com
Website: www.worldtest.com

# Spring Probe Vendors

**Everett Charles Technologies**
700 East Harrison Ave.
Pomona, CA 91767
Tel 909.625.5551
Web Site: www.ectinfo.com
Spring probes and receptacles
Turnkey fixturing and kits

**Interconnect Devices, LLC**
5101 Richland Avenue
Kansas City, KS 66106
Tel 913.342.5544
Web Site: www.idinet.com
Spring probes and receptacles

**QA Technology Company, LLC**
110 Towle Farm Road
Hampton, NH 03842
Tel 603.926.1193
Web Site: www.qatech.com
Spring probes and receptacles