



Introduction

This is a guide to assembling Merifix test fixture kits.

Due to careful selection of materials, use of modern manufacturing techniques, and supplying the kit "flat packed" for end-user assembly, Merifix fixture kits are inexpensive enough to be used in low-volume production and in engineering labs for programming and debug tasks, where traditional fixtures would be too expensive.

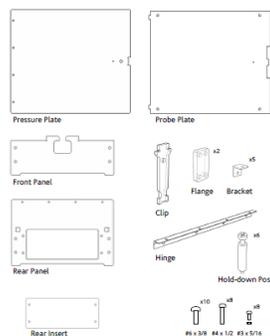
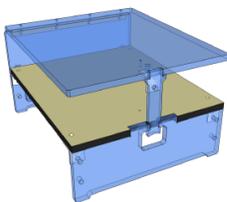
It is possible to assemble an accurate, functional fixture using only simple tools and some care; precision CNC machines are not needed. Completing a fixture should take anywhere from a couple of hours to half a day, depending on the complexity.

Merifix fixtures are available in several different sizes. The photos in this guide generally show the MF300 model, which has a 6" x 7" probe plate. The MF500 model has a 6" x 9" probe plate and the double-width MF700 has 12" x 9".

It is a good idea to read this guide through completely before starting work.

Things you will Need

Fixture kit



Merifix fixture kits include all the mechanical components of the fixture itself, along with the hold-down posts that press on the board from above.

Test probes

The test probes, which probe the board from below, are not included in the fixture kit because the quantity and type needed varies according to be board to be tested. These must be ordered separately along with the corresponding receptacles.

Drill

If you take advantage of the custom drilling service, you will not need to drill any holes.



The probe plate must be drilled for the test probes, and the pressure plate must be drilled for the hold-down posts. For the probe plate in particular it is most important that the holes be drilled accurately, cleanly and perpendicular to the plate (i.e. precisely vertical). A hand-held drill will not produce satisfactory results. A small drill press is ideal. The drill should have a chuck that is capable of holding the small drill bits that will be used.

Because the largest hole that must be drilled is only 1/8", a small hobby drill (e.g. a Dremel® tool) with a drill press accessory is adequate. This is the cheapest option and is quite capable of giving good results if used with care.



You will need drill bits suitable for the test probe receptacles, and a 1/8" drill bit for the hold-down posts.

Hand Tools and Materials

- Phillips screwdrivers for #3, #4 and #6 screws
- Flat-bladed screwdriver (for prying)
- Double-sided tape (e.g. Scotch® tape)

Boards to be Tested

If you are drilling the plates yourself one bare (unpopulated) board is required. This will be consumed during the assembly process. One completely assembled board will be required to check mechanical operation. This will not be damaged.



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Electronics

If the test fixture is to include any electronic components to aid testing these will be required along with mounting hardware. Mounting of boards with connectors that protrude through the rear insert is described in detail later.

If the test probes will simply be wired to a connector at the rear of the jig you will only need the connector and its mounting screws.

Selecting Probes

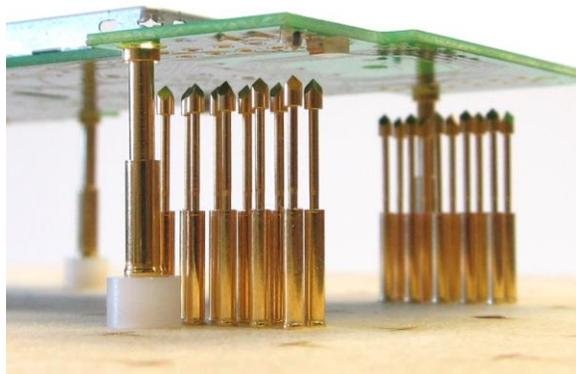
Probes come in two parts: the probe itself and a matching receptacle. Receptacles are fitted into holes drilled in the probe plate then probes are plugged into the receptacles. This allows probes to be replaced if they get damaged.

Probes are available in a variety of sizes and tip styles. Sizes compatible with Merifix fixtures are shown in the table.

Probe	Receptacle	Minimum Pitch
S-075	R-075	0.075" (2mm)
S-100	R-100	0.100" (2.5mm)

The board is positioned by using additional probes that locate in tooling or mounting holes in the board.

These probes typically have conical heads a little larger than those used for the test probes. They are mounted higher than the test probes so that the board sits on them and is then pressed down onto the test probes as the fixture is closed.



Recommended sizes for probes used for locating the board are shown in the table:

Probe	Receptacle	For tooling holes
S-3	R-3	up to 0.090" (2.3mm)
S-4	R-4	up to 0.145" (3.7mm)
GP-2	None	up to 0.195" (5.0mm)

Determining the Locations

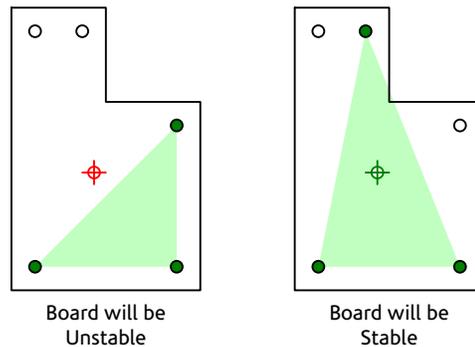
Test Probes

Decide where the board is to be probed. Typically this will be on test point locations provided for the purpose. The test points may be through-hole, with a pad on both sides of the board, or surface-mount, with a pad only on the bottom side of the board and no through hole.

It is also possible to probe on pads for components that are not fitted, such as a footprint for a debug connector, or pads for later connection of wires. It is not recommended to probe on pads where components are fitted.

Locating Probes

Decide on the positions for the probes that will be used for locating the board. At least three locations are required - four is normal - preferably near the edges of the board. For the board to be stably supported the centre of gravity of the board should be inside the polygon described by the locating probe locations.



The best holes to use for the locating probes are small (e.g. 0.062") tooling holes that are often provided for use during bare-board testing or pick-and-place assembly. It is also possible to use small mounting holes. In a pinch, holes for



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through-hole components may be used if these are unpopulated at the time of testing.

Hold-Down Posts

The hold-down posts are mounted on the pressure plate and will press down on the board as the pressure plate is lowered, pressing it down to make contact with the test probes. Decide where the hold-down posts will press on the board. Consider the following points:

- At least three locations are needed - four is more typical - distributed over the surface of the board.
- The tips of the hold-down posts should press on the surface of the board, not on components.
- All the hold-down post locations should be within the polygon described by the locating probe locations. At the very least, the rearmost hold-down posts should be forwards of the rearmost locating probes. This is to stop the board tilting as the fixture is closed.
- The locations should not be co-incident with test probe or locating probe locations. This is because if the fixture is closed with no board present the hold-down posts would hit the probes, possibly bending them.
- The hold-down posts must clear components. Check on a populated board that tall components are cleared.

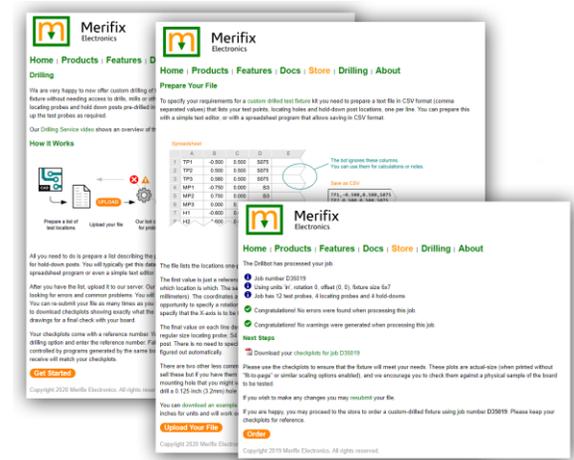
Custom Drilling Service

Merifix offers a custom drilling service that can drill the probe and pressure plates of the fixture for you.

This means you can purchase and assemble a fixture without needing access to drills, mills or other machine tools. Your fixture kit will be supplied with holes for test probes, locating probes and hold down posts pre-drilled in the exact locations you specify. You only need to assemble the kit and wire up the test probes as required.

The entire process is automated. You prepare and upload a simple text file describing the desired positions of the probes on your board. Automated design rule checks are run and drawings of the probe plate and pressure plate are prepared for you to download, view and check. Then after you place an order the plates of your fixture are machined by our CNC drills using programs generated by that same automated process.

Access the custom drilling service from the Merifix website at www.merifix.com or via the links from the online store. The website has full instructions. You can also download an example file so you can see how the process works.



Because the process is completely automated the cost is very low compared to traditional fixture manufacturing. This is the easiest and best way to achieve a high-quality, accurately drilled result.

Drilling the Probe Plate

If you are not using the custom drilling service then the probe plate can be manually drilled.

This section describes a straightforward way this can be done using simple tools.

If you take advantage of the custom drilling service, you can skip this whole section.





Marking the Locations

If the test points are through-hole then just mark the holes on the top side of the bare board. This bare board will be used as a template when drilling the probe plate.



If the test points are surface-mount (pads just on the bottom of the board with no plated-through hole) then centre-punch each pad and drill through. Drill with the same sized drill that will be used for the probe receptacles, then mark the holes on the top side of the board as above.

Also mark the holes chosen for use with locating probes, and the locations chosen for the hold-down posts, on the top side of the board.

Positioning the Board

Position the board, top-side up, on the probe plate. The best location is towards the front of the plate, roughly centered. Keeping the board towards the front ensures that the hold-down posts are as vertical as possible when they land on the board as the fixture is operated. If the board is positioned towards the rear there is more tendency for the board to be tilted as the fixture closes.

The probe plate is engraved with a helpful grid on 1/2" centers, and a small tooling hole marks a notional origin. These features line up exactly with corresponding features on the pressure plate which will be helpful later when drilling the pressure plate.

Position the bare board on the probe plate, aligned with the grid in a way that seems suitable. Fix the board to the probe plate with

double-sided tape. This will hold the board in position as the holes are drilled and allow the board to be removed afterwards.



Make a note of how the board is aligned with the grid so that you can place it in the same relative position on the pressure plate later.

Preparation for Drilling

Select the drill bit suitable for the test probe receptacles. Common sizes are shown in the table:

Probe	Receptacle	Drill	
S-075	R-075	#55	0.052"
S-100	R-100	#51	0.067"

Warning: Carbide drills are brittle and will break if mishandled. Always wear safety glasses when using machine tools.



Drilling the probe plate is the most important part of construction and the care with which this is done will largely determine the performance of the fixture.

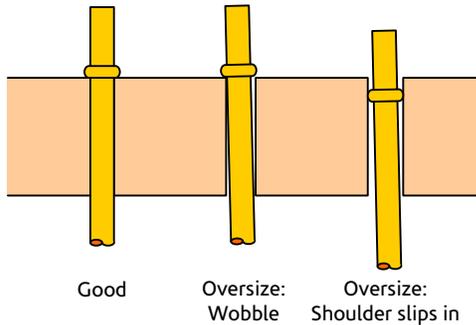
The probe plate is medium density fibreboard which drills very easily. Before drilling the probe plate, drill some practice holes on the spare piece that is supplied for this purpose. Check the drilled holes by inserting a test probe receptacle. The receptacle should be a snug fit in the hole. You should be able to press it in until the shoulder sits against the surface.

If the receptacle can wobble in the hole, or the shoulder can slip down into the top of the hole then the hole is oversized. Do not proceed to drill

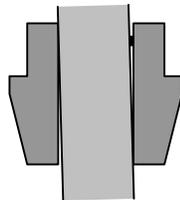


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the probe plate until you have corrected the problem.



The most common cause of oversize holes is drill wobble (run-out), and the most common cause of drill wobble is that the drill is not true in the chuck. This can be caused by even microscopic pieces of dirt in the chuck or on the drill shank.



Dirt in Chuck Jaw causes Drill Wobble

Clean the drill shank with a cloth and some light oil. Clean the chuck by removing it from the tool and blowing it out with compressed air. If necessary, disassemble it and clean the jaws.



If possible, use a collet rather than an adjustable three-jaw chuck. The drills available from Merifix all have 1/8" shanks. This size collet is often

supplied with miniature drills and high-speed rotary tools, and they can be readily purchased.



Because a collet only fits one size of shank and does not have to adjust to cover a whole range it inherently has more accuracy than a general purpose chuck. Again, ensure that the drill and collet are clean.

Other Tips for Drilling

Drill in one swift motion - down then up. The probe plate material is soft and will drill easily. There is no need to lower and raise the drill several times to clear swarf. Doing so will only increase the likelihood of drilling oversize. Similarly, plunging the drill slowly, so it remains in the hole for a long time, just provides opportunity for the drill to wear away at the hole sidewalls.

Hold the probe plate down firmly against the bed of the drill press. Do not let it wander once the drill has entered, and do not allow it to lift up when extracting the drill.

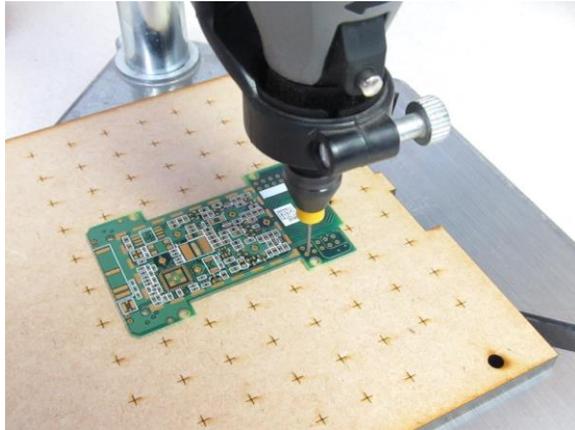
If you are using a high-speed rotary tool (e.g. a Dremel® tool) select the lowest speed. There is no need to use the higher speeds because the probe plate material is soft. Higher speeds will tend to result in oversize holes.

Good, bright task lighting directly on the work can make it much easier to see what you are doing and can make a big difference to the overall result.



Drilling for Test Probe Receptacles

With the bare board firmly fixed to the probe plate carefully drill through all the marked test point locations. Allow the holes in the bare board to guide the drill. Once the drill has centered in the hole in the board hold the work firmly as you drill through the plate itself.



Because the bare board was very accurately CNC drilled by the PCB manufacturer, using it as a drilling template ensures accurate results.

Drilling for Locating Probe Receptacles

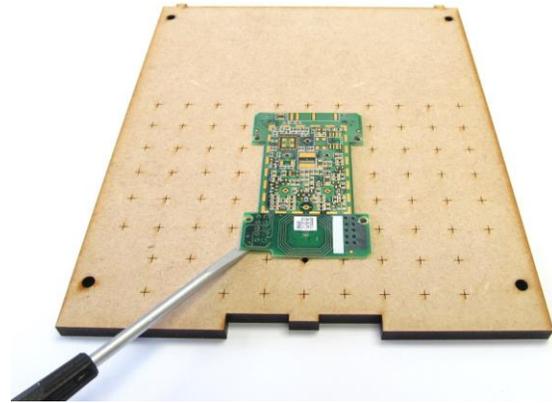
Select the drill bit suitable for the locating probe receptacles. Common sizes are shown in the table:

Probe	Receptacle	Drill	
S-3	R-3	#42	0.093"
S-4	R-4	#36	0.106"
GP-2	None		5.0mm

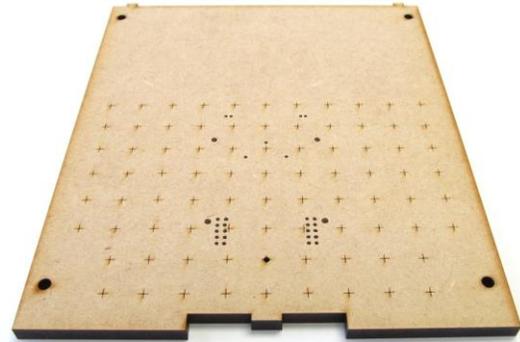
Carefully drill through the marked locating hole locations.

Removing the Board

Carefully remove the board from the probe plate. It can be pried up off the tape using a small flat-bladed screwdriver or a similar tool.



Tape residue can be removed from the probe plate with fresh tape. The drilled probe plate is now complete.



Alternative CNC Method

If you have access to a CNC drill or mill it is entirely possible to drill the probe plate by calculation and measurement rather than by drilling through a bare board. You will need CAD files for the PCB that give the coordinates of the test points to be probed.

When machining, use the small tooling hole in the probe plate as an origin marker. It aligns exactly with the corresponding hole in the pressure plate.

This method can give excellent results. However, without a physical board in front of you it is easy to make a mistake such as getting the coordinates reversed or not noticing a mechanical clash. Double check hole locations before drilling!

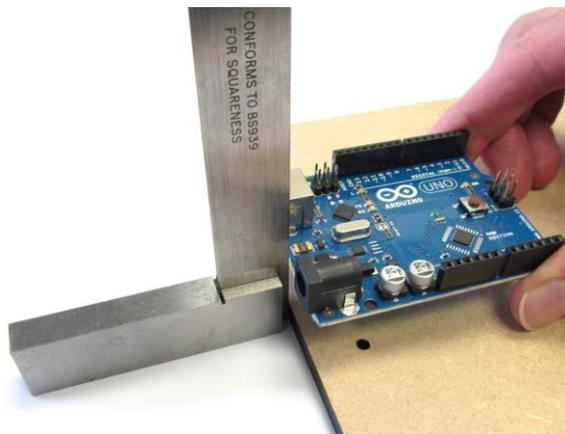


Drilling Holes for Internal Electronics

In some situations the test probes are simply wired to a connector on the rear of the fixture which is then connected via a cable to an external test system.

In other situations simple electronics may be incorporated in the fixture to make a more self-contained system. If the fixture is to have such test circuit boards or other items mounted under the probe plate, now is the most convenient time to drill whatever mounting holes are needed.

If the test circuit board includes connectors that should poke through the rear panel, position the test circuit board with its edge exactly aligned with the rear edge of the probe plate. This will align with the inner face of the rear insert when the fixture is assembled.



For some common test circuit boards, probe plates may be available with suitable mounting holes pre-cut.

Drilling the Pressure Plate

If you are not using the custom drilling service then the pressure plate can be manually drilled.

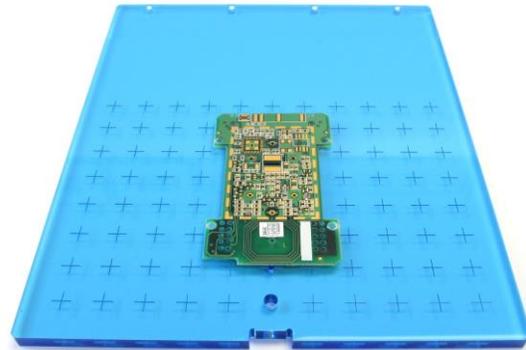
This section describes a straightforward way this can be done using simple tools.

If you take advantage of the custom drilling service, you can skip this whole section.



Positioning the Board

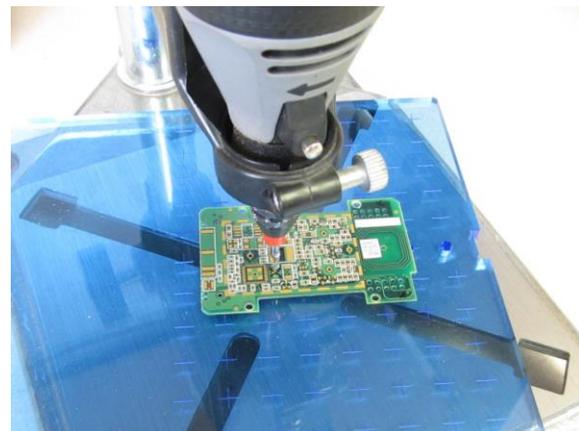
Position the bare board on the pressure plate in the same location that it was on the probe plate. Remember that the engraved markings on the pressure plate correspond exactly with those on the probe plate. Fix the board to the pressure plate with double-sided tape.



Drilling for Hold-Down Posts

A 1/8" drill is required for the hold-down posts.

With the bare board firmly fixed to the pressure plate carefully drill through all the marked hold-down post locations.



The pressure plate is acrylic. It is a fairly soft plastic and will drill easily but can crack if stressed, so drill carefully with a low feed rate and raise the drill out of the hole several times to clear swarf rather than trying to drill all the way through in one go. A little mineral oil (e.g. 3-in-1®) can be used for lubrication.



Removing the Board

Carefully remove the board from the pressure plate. It can be pried up off the tape using a small flat-bladed screwdriver or similar.

Adhesive residue can be removed from the pressure plate using fresh tape, or cleaned off with mineral oil. Isopropyl alcohol can also be used if applied sparingly and wiped off promptly. Do not use other solvents as they can damage the surface finish.

Alternative CNC Method

Again, if you have access to a CNC drill or mill it is possible to drill the pressure plate by calculation and measurement rather than by drilling through a bare board. When machining, use the small tooling hole in the pressure plate as an origin marker.

Machining the Rear Insert

The rear insert is intended to accommodate whatever mounting holes and cut-outs are needed for the connectors that will be used to connect external equipment to the fixture.

Typically the connectors will either mount directly on the rear insert and be wired directly to the test probes, or the connectors will be on a circuit board mounted under the probe plate, which will itself be wired to the test probes.

Panel Mounted Connectors

For connectors mounted directly on the rear insert, pre-cut inserts are available with holes for many common types including D-sub and rectangular connectors.

If you are using a connector for which a pre-cut rear insert is not available you will need to machine the blank insert to suit. The rear insert is 1/8" acrylic which is fairly soft and will drill or cut easily. It can crack if stressed, so drill carefully with a low feed rate and use a little mineral oil (e.g. 3-in-1®) for lubrication.

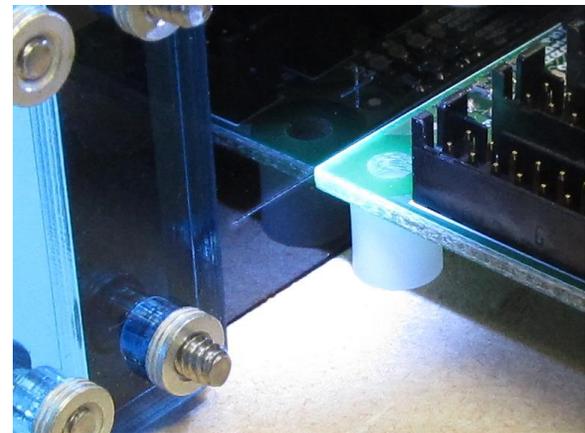
The inside surface of the blank insert is engraved with some lines that will help in positioning

connectors. An outline marks the maximum useable area. Within this, a 1/2" grid helps with centering and aligning cut-outs.

Board Mounted Connectors

If your fixture will have a circuit board (a programmer, a JTAG interface, a data acquisition board, etc.) mounted under the probe plate that has connectors that must fit through the rear insert then the blank rear insert must typically be machined to suit.

There is one additional engraved feature on the rear insert that will help in this situation. If your circuit board is the standard 1/16" (1.6mm) thick and you mount it under the probe plate on standard 1/4" (6mm) spacers or standoffs, then the component side of the board (with the connectors on) will align with a horizontal line engraved on the rear insert.



This board-surface line will help with positioning cut-outs for board mounted connectors. Measure the size and position of the connector features relative to the board, then mark up the rear insert by measuring relative to the board-surface line.



Assembling the Fixture

Assembling the Rear Panel

Attach the flanges to the rear panel using two #4 screws per flange through the rear panel into the PEM nuts broached to the flanges. The flanges will end up on the internal surface of the rear panel.



For the largest size fixture there are two rear panels and four flanges.

Attach two brackets to the rear panel on the same side as the flanges, using #6 screws. The brackets will support the underside of the probe plate.



Attach the hinge to the rear panel using four #3 screws and nuts. The hinge should be fixed to the same side of the panel as the flanges and brackets, and the panel should be on this same inside surface. The hinge will support the underside of the pressure plate.



For the largest size fixture there are two hinges, attached with eight screws and nuts.

Assembling the Front Panel

Attach two brackets to the front panel using #6 screws. The brackets should be secured to the internal surface of the panel. The surface with the Merifix logo is the external one.



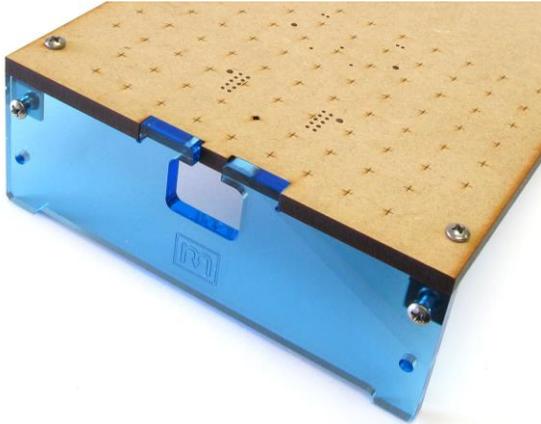
The brackets will support the underside of the probe plate.



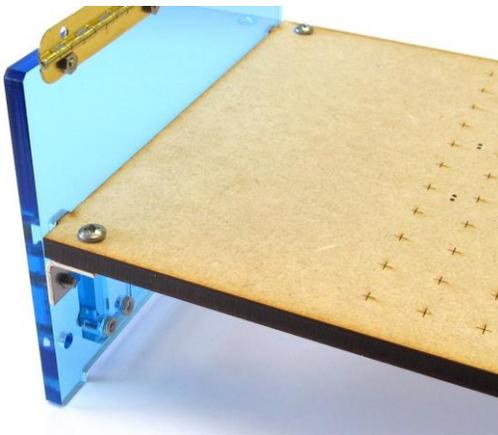
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Assembling the Probe plate

Attach the probe plate to the front panel brackets with #6 screws. Make sure the probe plate is the right way up - the surface with the engraved marks, to which the bare board was attached when drilling, should be uppermost.



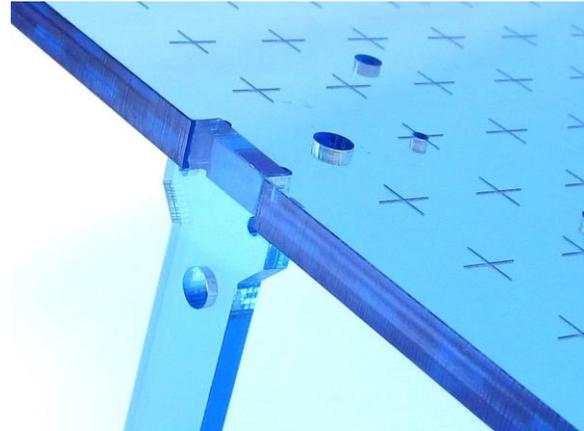
Insert the tabs of the probe plate into the corresponding cut-outs in the rear panel. Secure the probe plate to the rear panel brackets with #6 screws.



Ensure all parts are properly located and square, and that the fixture sits squarely on a flat surface, then tighten all the screws.

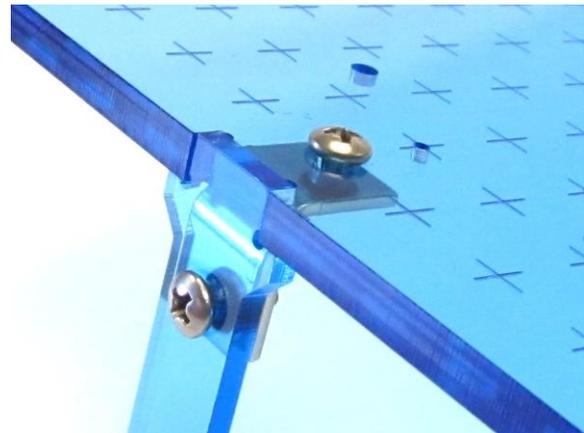
Assembling the Pressure Plate

Press the clip firmly into its slot in the pressure plate. It is a tight fit. Ensure that it is square in the slot and pressed fully home. Make sure the pressure plate is the right way up - the surface with the engraved marks should be uppermost.



Note that the clip may be made of white Delrin rather than the blue acrylic shown in the photos. This change was made for improved robustness.

Attach a bracket between the pressure plate and the clip using #6 screws.





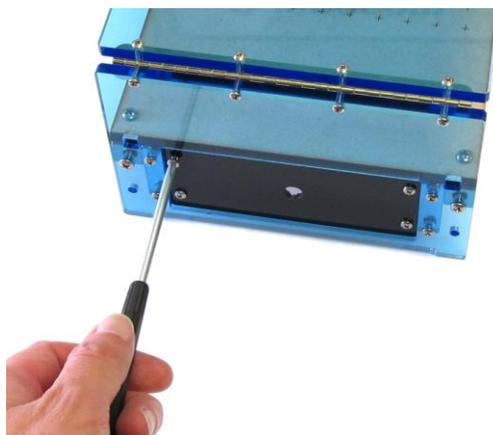
Attach the pressure plate to the hinge on the rear panel using four #3 screws and nuts. The hinge should be fixed to the bottom surface of the pressure plate and the nuts should be on this same bottom side.



Check that the pressure plate hinges smoothly, and that the clip engages properly with the front panel when the pressure plate is closed. Tighten the screws.

Assembling the Rear Insert

Place the rear insert into the opening in the rear panel and attach it to the flanges using four #4 screws.



Because the rear insert is a separate piece it may be removed and replaced easily, without having to disassemble the fixture. This will be convenient later when assembling and wiring rear connectors, or fitting electronics under the probe plate.

Completing the Probe Plate

Installing Receptacles

Install the receptacles for the test probes in the probe plate. Insert the receptacles into the drilled holes from the top side, making sure that the open end of the receptacle (where the test probe goes) is uppermost. Press each receptacle down into its hole until the small shoulder sits against the surface of the probe plate.



If the holes in the probe plate have been drilled exactly to size the receptacles should be a snug fit. If necessary tap or press against the top surface of the receptacle using a scrap piece of a soft material such as plastic to protect the receptacle. Do not strike the receptacle directly, and especially do not use a hard-faced tool such as hammer, as this will likely damage the receptacle. Do not "wiggle" the receptacle as this can enlarge the hole and reduce pointing accuracy.

If the holes in the probe plate are slightly oversize then a tiny dab of glue in the hole may be used to help secure the receptacles. In practice there is little danger of them pulling out since in normal operation the receptacles will be pressed into the holes by the action of the pressure plate.

Install the receptacles for the locating probes next. These are inserted in the same way as the test receptacles. The small collar fitted over each receptacle raises the receptacle slightly and ensures that the locating probes are slightly higher than the test probes. Different sized collars are distinguished by color; R-3 receptacles



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have a white collar and R-4 have black. The GP-2 locating probes do not use receptacles.

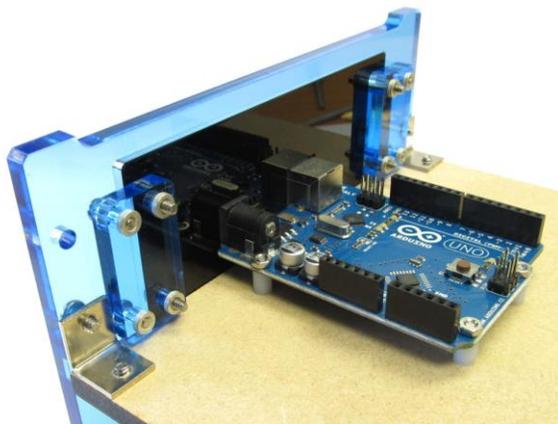


When a board is placed on the fixture it will sit on the locating probes. When the pressure plate is lowered the board will be forced down to meet the test probes.

Installing Internal Electronics

If your fixture will have a circuit board (a programmer, a JTAG interface, a data acquisition board, etc.) mounted under the probe plate then fit it now using the holes you drilled earlier.

The typical method is to use 1/4" (6mm) spacers or standoffs to mount the board to the underside of the probe plate.



If the mounting holes in the board have nearby traces or components then nylon mounting hardware can be used to avoid short circuits.

Wiring

Wire the receptacles to the rear connector (or to the internal circuit board if there is one).

Wire-wrapping

Wire-wrapping, although no longer widely used as a production or prototyping technique, is still common in the assembly of test fixtures. Test probe receptacles are available with wire-wrap posts, as are many of the types of connectors commonly used on the rear panel, such as D-sub and rectangular connectors. This technique is popular because it makes strong, reliable joints quickly and because it is easy to make connections in a field of densely packed test probes.

If you are using receptacles and rear panel connector(s) with wire-wrapping posts then make the connections between them using suitable wire and a hand tool. Leave some slack in the wires so that the joints are not stressed, and so that it is possible to disassemble the fixture (or at least remove the rear insert) if necessary. A neat result is obtained by bundling the wires together with lacing cord (or miniature cable ties).

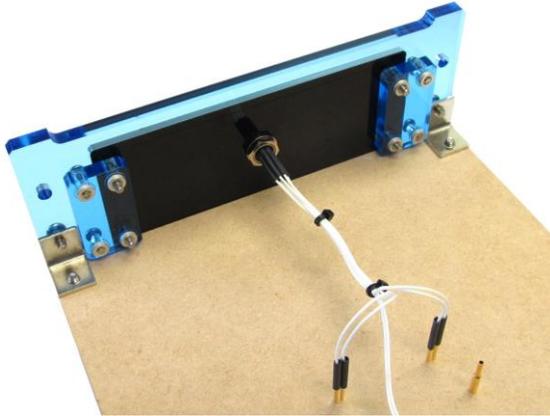
Soldering

If you are using receptacles and rear panel connector(s) with pins intended for soldering then make the connections using suitable wire and a soldering iron with a small tip.

The most suitable wire is stranded (not solid core) in a small size such as 28 or 30 AWG. PTFE (Teflon®) insulation is preferable because it will not melt if inadvertently touched with the soldering iron (which is easy to do when working on small connectors or closely-spaced receptacles), and because it is thinner than PVC. However, other types of insulation can be used if desired.



The wires can be bundled using miniature cable ties. A bundled cable is likely to be more reliable, and to stand up to normal handling better than a collection of loose wires.



Small heat-shrink sleeves over the soldered connections give a neat result and prevent short circuits.

Installing probes in receptacles

After wiring the receptacles, turn the fixture over and insert the probes in the receptacles.

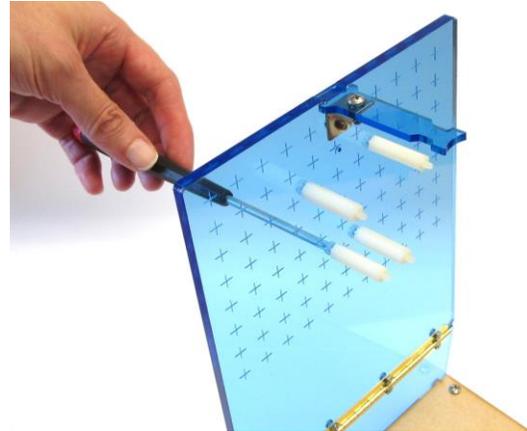


Handling the probes with tweezers can make things easier when the probes are closely spaced. Push the probes all the way in to the receptacles until they are properly seated. If necessary press on the tips with a soft plastic tool. Do not press on the probe tips with a metal tool since this may blunt them and lead to unreliable contact.

Completing the Pressure Plate

Installing Hold-down posts

Install the hold-down posts in the pressure plate through the holes drilled earlier. The posts are in two pieces: the nylon screw is inserted through from the top of the pressure plate and the nylon sleeve is screwed onto it from the other side.



If the hold-down posts will press against the bare board as recommended then no adjustment in their height should be needed.

If one or more hold-down posts must press against components then their height must be adjusted. Small adjustments in height, such as when pressing against a surface mount chip package, may be made by inserting one or more washers under the head of the nylon screw.

If a larger adjustment in height is required then the nylon screw and sleeve must be cut to length.

Installing a Base Plate

Optional base plates provide protection of the fixture wiring from handling and give more rigidity, useful with a large number of probes.

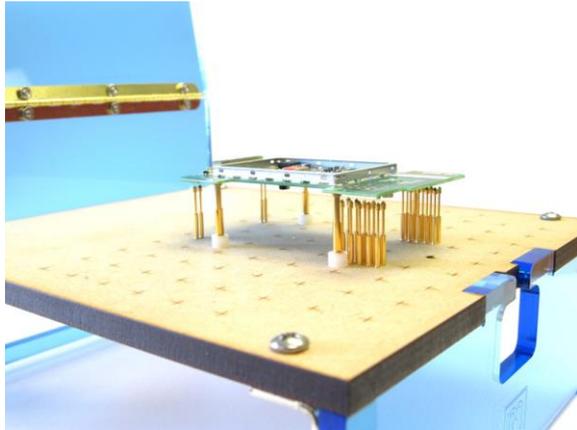
Optional base plate kits include the mounting hardware. To install the base plate attach two brackets to the rear panel and two brackets to the front panel using #6 screws. Then attach the base plate to the brackets also using #6 screws.



Testing Mechanical Operation

Close the fixture carefully and make sure the hold-down posts clear the test probes.

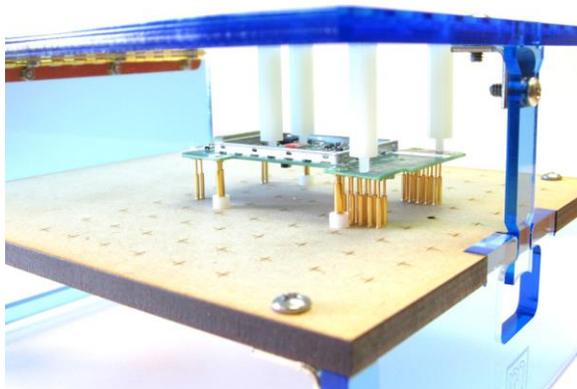
Open the fixture again and place a board on the locating probes.



Close the fixture and ensure that the board remains properly seated as the hold-down posts land on it.

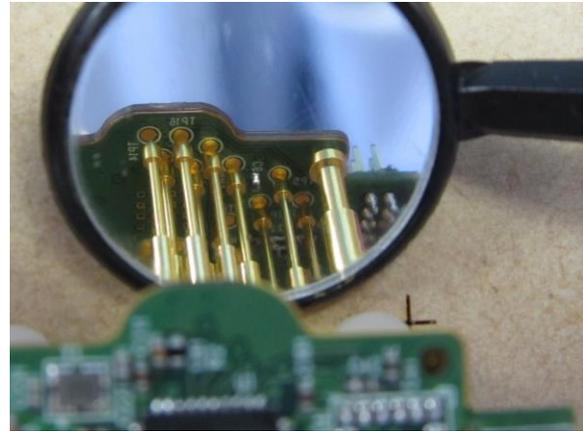
Ensure that as the fixture is fully closed the locating probes compress, then the test probes compress. Ensure that the probes do not "bottom out" before the fixture is fully closed.

Make sure the clip engages properly with the front panel and "clicks" shut.

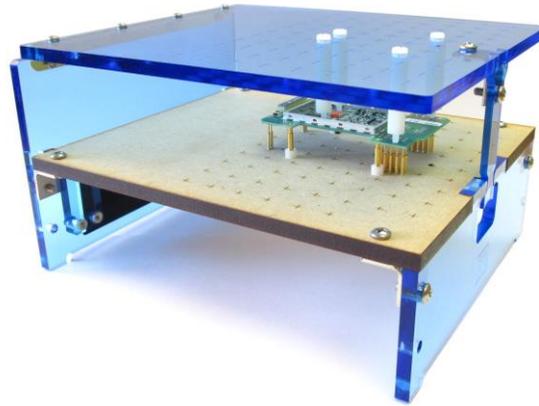


With the fixture closed inspect the board from underneath, using a small mirror if necessary, and ensure that the test probes have landed correctly on the test points.

With through-hole test points the probes will tend to self-centre in the holes. With surface-mount test points (as shown below) it is more important to ensure that the probes are landing in the centre of the pads.



Release the clip and see that the pressure plate opens. Ensure that it opens completely (just past the vertical) and is stable in the open position.



The fixture is now complete!