INTRODUCTION

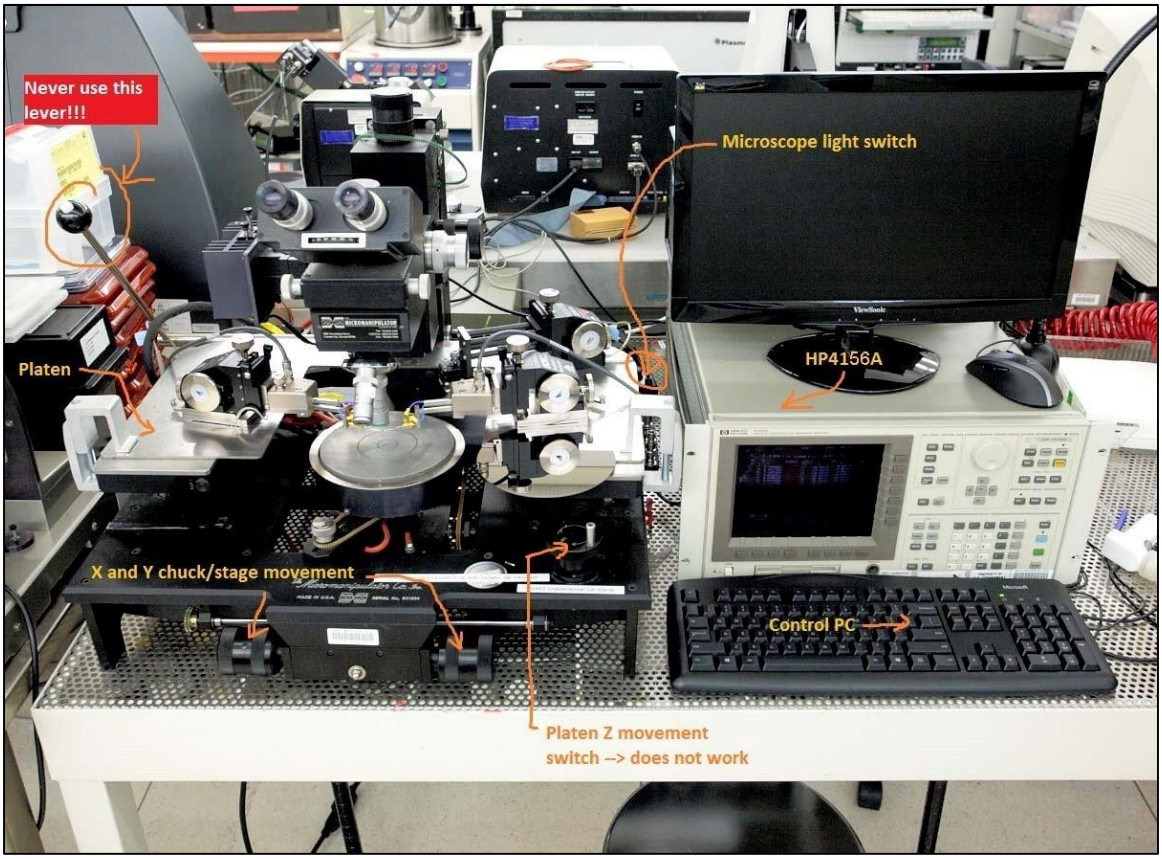
The prober is a DC probe station for device characterization. The system currently uses four probe positioners and a chuck. Bias can be used to run electrical measurements.
This SOP and the associated training on the tool only cover the very basic operation. For any problems, more complex measurements, any extra probes, wires, probe tips, etc. – please contact the staff for further assistance or training.

SAFETY

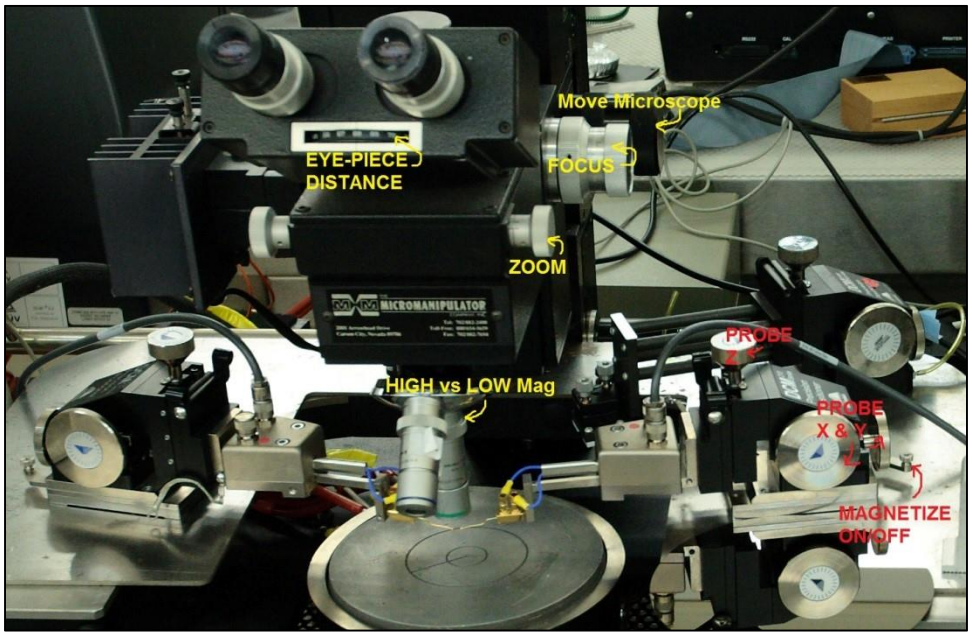
Probe tips are sharp. If moving the positioners around or lifting them off the platen, do not place them where you can collide with the probe tips – i.e. don't have the tips face you. **DC voltages above 40V are dangerous** and in addition to electric shock can cause blood electrolysis. If you need to run measurements in excess of 40V please talk to the staff for additional training.

PROCEDURE

During your training session, you will create a copy of the MATLAB scripts in your home directory. This procedure is outlined in the appendix at the end. There are four scripts for 1) diodes and resistors, 2) BJTs, 3) MOSFETs, 4) Four-point probe measurements. The photo below shows some of the names and locations for the probe station parts. A more detailed view of the positioners and microscope controls will be on the next page.



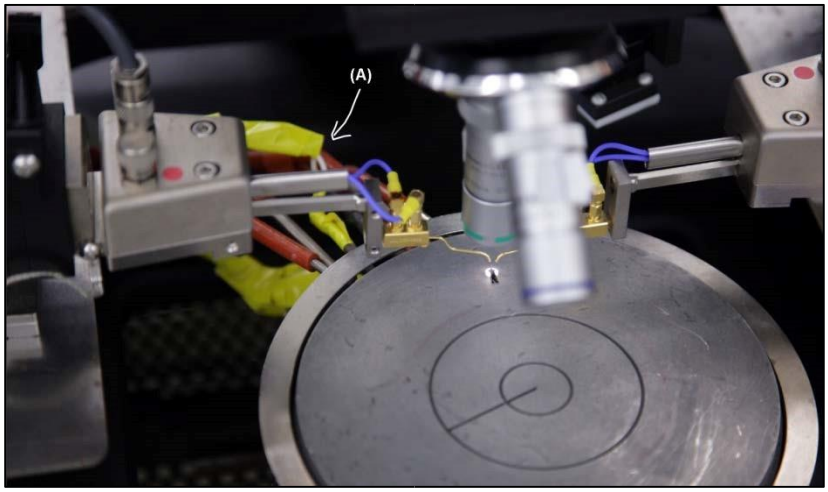
0. Check reservations in the log book to insure that you reserved the correct machine in the correct facility for the correct date. Another user may have reservations; it is your responsibility to honor them, if this is the case
1. Turn **on the microscope light**.



2. Make sure the **positioners are moved up** (e.g. 2 mm above the chuck), to prevent damaging them or your substrate when you load and adjust your sample. The photo below shows some of the detailed microscope mechanisms that we will refer to.

3. Set up the probe station and load your sample. Adjust positioners' location on the platen so that probe tips are close enough (e.g. **2-3 mm apart**) together to reach your device when adjusting X and Y movements. Often they are already in a good place and no action is needed, but some users may have moved them to accommodate larger devices. Be careful not to place the tips too close together by hand, since it can result in accidental crashing of the tips into each other. Fine adjustments will be done with the micrometers, and not by moving the positioners around on the platen. When moving the positioners, make sure to unlock the **magnetic fasteners** (by flipping the "magnetize on/off" lever identified in the photo above) and then gently move the positioners around – otherwise they are hard to move and the excess force you will apply can damage the micrometers. Also remember that the microscope can be moved in X and Y. Check that the **microscope position is centered in X**, and moved **back in Y** (away from you).

4. Check again that the probe tips are sufficiently high up, and then **load your sample**. Place sample on chuck and adjust the sample and the move the chuck as needed. Always pay attention to the probe tips so that you don't accidentally run the tips into your sample (which can scratch up and damage your devices and the probe tips). Please do not use the probes when there is photoresist or other organics near the test sites, because the residues quickly clog up the probe tips.



5. Focus the microscope on your sample, find a device to test, and then **lower the probe tips** one at a time, and adjust their X and Y position. **If you can't see the tips** (initially as dark shadows that move into focus as you lower them), then stop - you need to first adjust the X and Y to be in the field of view. Otherwise you won't easily notice if you lower them too far. Typically, you will do 1) move the tips so they show up as diffuse shadows in the field of view, 2) start lowering them until they almost touch the sample, 3) move them into position above your test pads, 4) lower them to touch the device (next step). The right photo above shows the left tip in focus (labeled A), while the right tip is still higher up and out of focus (labeled B). If you use the high magnification, that diffuse shadow will be a lot weaker than what you see in the photo.

   HINT: To switch the microscope objective, **do not** rotate the turret while the objective is between the probe tips. There will not be enough room to rotate, even if you move the microscope zoom up, and you will bump into the probes causing damage to them and your device. Instead, use the microscope movement knobs to move the microscope towards you. Now, with the objective out of the way of the probe tips, you will be able to rotate the turret without problems.

6. Lower the probe tips to **contact your device**. The probe tips should be in focus with your device, and you should see the tips move forward slightly (called "overdrive"). The overdrive should be very small: you are looking for just a very tiny movement of the probe tip, and it should not "skate" along the pad. Also note that for small samples, the first probe tip to contact the sample can push it forward. Again, lower the probe tips one at a time, and stop as soon as you see either the probe skate on the sample or the sample move from the probe pressing on it.

   CAUTION: Once the probe tips are contacting the sample, be very careful not to bump into the system. Vibrations and shocks are bad news for the contact quality, and can also damage the tips. Moving the chuck is particularly bad, because the tips will scratch your sample and also get bent.

   To move to a new device always raise the probes with the Z micrometers, and then either move the probes with their X- and Y-micrometers (if the new device is nearby in the current field of view), or use the chuck movement for adjusting the sample for larger movements.

   Design Hint: A brand-new probe has a 5 µm diameter tip. But that does not translate into the ability to measure pads of that size. Wear-and-tear or improper use can also dull the tips. Therefore, for test pads to your device, a 100 µm sized square or larger provides a very comfortable space to land the probe on – and it gives you extra room in case you wear down the pad from repeated probing. You can use smaller pads if necessary, and pads down to 50 µm can still be probed. But even smaller pads become increasingly challenging to measure. We recommend pads of 100 µm or larger, so that you have an easy time to probe and are tolerant to different probe tip conditions.

7. **Run your measurement**.

8. To measure a different device, use the Z micrometers to **lift the probe tips**, and **reposition** the stage to the new device. The tips should be lifted enough to avoid accidental scratching of your If the device is already in view, you can just use the X- and Y- micrometers instead. The stage positioning may not be accurate enough to exactly land the probe tips over your pads. Use the X- and Y-micrometers to do the fine positioning. Then **lower the probe tips** and continue with a new measurement.

9. Once you are done, or when moving to a far out wafer location, use the Z micrometers **to raise the probe tips** to 2-3 mm above your sample, and then unload your sample. Move the chuck towards you if needed and then slide the sample out. Be careful with wafers, and avoid tilting it as you lift since that may crash your wafer into the probe tips.

10. **Turn off** the microscope light.

11. In the comment field of the log book, please **describe the probe tip condition**. This helps us track the state of the tips and when to replace them. Please be specific: e.g. if the tip was not in great shape, if dirt had accumulated on then, if you had difficulties measuring with both tips on a gold pad, if you noticed that you accidentally jammed or scratched it across your substrate, etc.

12. **If the probe tips are damaged**, please report that as a "Problem" in the log book. If you are not sure if the tips are in good shape or not, please report this as a "Comment".

OTHER NOTES:

1. Not all metals are easy to probe. Gold is great since it's soft and the probe can dig in easily. Aluminum is a good choice, but is more vibration sensitive (as it oxidizes and accumulates on the tungsten probe tips) – and the contact resistance can increase over time (e.g. after a few minutes or after you rattle the table). Whether this matters depends on your device. If you see such an increase, don't just dig the probe tips in deeper (not great for the probes), but instead move them up in Z, and then adjust slightly to a new position and lower them down again. In those cases, be prepared – get ready to run the measurement program, then lower the probe tips, and start the measurement. If you're really worried about this, run a second identical measurement and compare the data.
2. Depending on the pad material, the metal thickness sufficient for probe pads can be made quite thin. A good thickness for gold pads is 100 nm, although we have probed resistor structures with gold films of 50 nm and less. Especially if the pads are large (e.g. >100 µm), you can use thinner films because the pad will be large enough to offer places to probe even when repeated probing causes some wear.