

## Fast and safe electrical probing

One of the simplest tasks in the world of electronics is the measurement of an I-V curve of a single transistor. However, if the size of a transistor is reduced to a few hundred nanometers, this task becomes very challenging. A lot of investigation into different sciences is needed to overcome the problems associated with such miniaturization.

Electrical measurement of small structures requires high positioning accuracy and a very stable probing system. In addition to this, probe tips need to be small enough to land on the contacts, rigid enough to avoid fish-hooking the tip, ductile enough to avoid breaking the tip and highly conductive.

This document explains how to measure transistor characteristics using a conventional SEM or FIB and an array of our MM3A-EM micromanipulators.

### Fast system setup

A typical probing system consists of four or more manipulators mounted so that the transistor can be accessed from all sides. The position of the manipulators can easily be changed by sliding them into the desired slots in the adaptor plate.



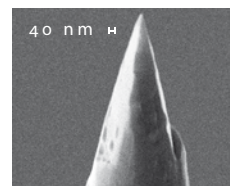
The complete probing system can be installed in most commercially available SEM & FIB microscopes in a just few minutes.

The manipulators can be pre-positioned by hand. The control electronics allow various movement speeds in order to move the probe tips quickly and accurately into the field of view.

The probe tips should be bent to an attack angle of around 45°. Higher angles reduce visibility while smaller angles reduce the force that can be applied to the contact point.



Tungsten probe tip inserted into the tip holder



Probe tip PT-30 with a tip radius of about 20 nm

### Sample and tip preparation

A reliable contact requires a clean sample and oxide-free probe tips. A variety of sample cleaning devices are commercially available, but probe tips that are highly conductive and have a sub 100 nm tip radius are more difficult to obtain.

FIB-reprocessed probe tips together with our recently developed tip cleaning process allow for reliable probing on sub 100 nm structures.

### Approaching the sample

One of the biggest problems when probing is the approach of the probe tip to the region of interest without damaging the sample or the tip. This process is very time consuming when performed manually.

Using the Safe Tip Approach (STA) system this procedure is made faster, more simple and more secure even for inexperienced users. Just before the tip reaches the sample, a small tunnel current is sensed and the approach of the manipulator is immediately halted.

The fastest method of using the STA is to connect a structure on the sample to ground (usually the substrate). Where this is not possible, the first probe tip is pre-positioned and used as reference ground for the other tips by activating a switch on the STA module. All other tips can be then be positioned in the region of interest within minutes.



Front panel of the Safe Tip Approach module

### Damage-free contact

The manipulators can be moved with a resolution of approximately 5 nm in the two rotational axes and 0.25 nm in the linear axis. High resolution of this nature gives the user very fine control over the probe tip and helps to prevent damaging sensitive samples.

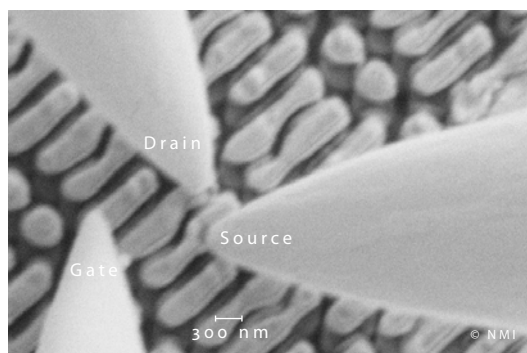
The complete process of contacting a transistor, from system installation to the start of the measurement, usually takes one hour.

### Stable electrical measurements

With a drift of less than 1 nm per minute our manipulators are well suited to the measurement of different parameters on very small structures.

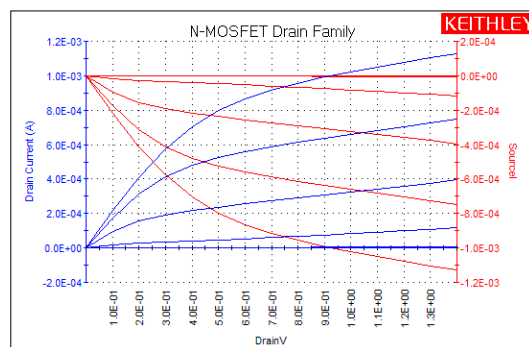
Electrical probing of non-aggressive technology can be performed with the standard MM3A-EM micromanipulator. Voltages and currents can be applied and measured through the tip of the manipulator and are accessed via BNC connectors on the air-side splitter box or STA module.

For low-current, low-capacity measurements on conductive samples, a low-current measurement



Probe tips on 200 nm contact pads of a transistor

kit (LCMK-EM) is available as a plug-in tool for the MM3A-EM. With this tool currents as low as 1 pA can be measured. The leakage current between inner and guard conductor is 100 fA at 3 V. Signals are fed through separate vacuum compatible triax cables and adapters for all conventional parameter analyzers are available.



I-V curves from a transistor built on 90 nm technology

### Further information

- Contact us at [info@nanotechnik.com](mailto:info@nanotechnik.com)
- Find your local agent at [www.nanotechnik.com](http://www.nanotechnik.com)

Micromanipulator fitted with a low-current measurement kit

