

## Bias Control Option

The NanoInk NSCRIPTOR™ DPN® System is optimized for Dip Pen Nanolithography® (DPN) experiments, using a pen-based ink deposition technology. The Bias Control Option adds the capability in contact mode of introducing an electrical bias between the probe tip and the substrate. It is now possible to explore the potential of electro-chemical DPN and other nanolithography techniques (for example oxidation nanolithography) as well as a multitude of new inspection techniques, including conductive AFM (C-AFM).

### ***Items Included***

The Bias Control Option includes the following items:

- 1 BNC coaxial cable, 6' long
- 1 stage cable (A 3' coaxial cable with a BNC connector that splits into two 3' single wires with unequal terminations. One termination is a silver subminiature phono plug; the other is a golden pin.)
- 1 integrated scanner back plate with circuit board
- 1 switch box
- 1 insulating sample puck layer
- 1 set of conductive probes

### ***Item Description***

- Scanner back plate
  - For proper connectivity to Bias Control Option components, required by system
- Switch box
  - The switch box is used to route the bias signal from a selectable source to the tip area
  - Supports an internal voltage supply or an externally supplied voltage source
  - The basic setup using internal bias is shown in the top half of Figure 1
  - Voltage range for internal supply between 0 - 10 volts
  - The polarity switch provides positive voltage from biasing either the tip or a negative voltage when biasing the insulated puck (i.e., a 'negative' setting is equivalent to having negative bias on the tip)
  - InkCAD™ software supports contact mode writing with a voltage bias of positive and negative polarity by using multiple design layers and switching the polarity in between writing each nanolithography layer
  - When using an external voltage source, the internal supply can be used as a trigger signal
  - Setup for an external source with triggering includes the same connections as for internal
  - The resistance at 0V bias across the DAC output is less than 2 Ohms
- 1 insulating sample puck layer
  - The layered sample puck is modified to accommodate biasing of the sample
  - A black insulating sample puck layer is inserted to isolate the sample from stage ground
- 1 set of conductive contact mode probes
  - Commercially available conductive probe mount straight into the tip clip.
  - Doped silicon probes or metal-coated probes can be used for bias control applications
  - NanoInk's standard silicon nitride probes are not suitable for use with bias control

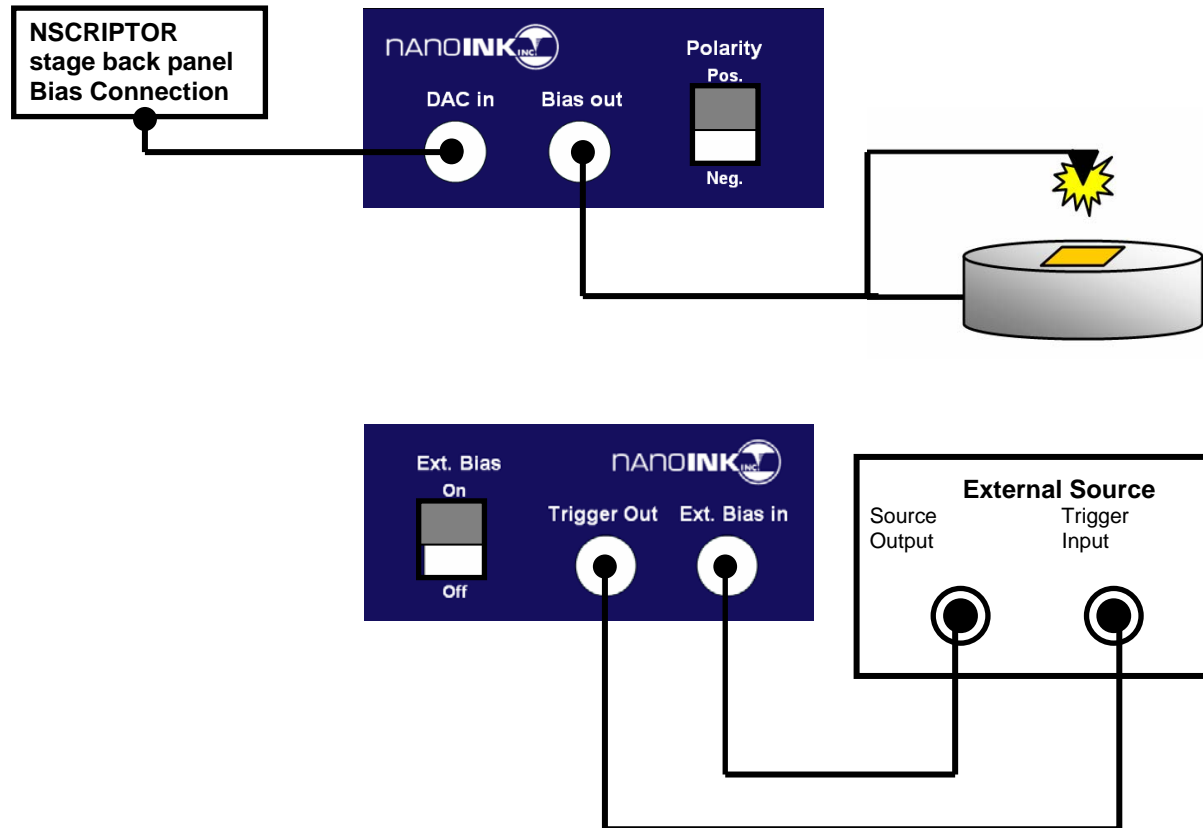


Figure 1: Electrical connection schematic



Figure 2: Modified sample puck with grounding layer and voltage cable connection

### Software Specifications

- InkCAD allows one to enable or disable bias switching during the writing of a given layer
- Two different bias values can be specified for each layer, called lithography bias and rest bias
- Lithography bias is used while features are written and rest bias is applied in between writing
- When 'lift probes between drawn objects' is chosen in the layer properties, the following sequence of actions applies: tip down, lithography bias on, write, tip up, rest bias on

To learn about the bias switching logic applied, please refer to Table 1

Event	Bias Value = 0V	Bias Value = Rest Bias	Bias Value = Lithography Bias
InkCAD startup	x		
InkCAD shutdown	x		
Server started	x		
Tip exchange started	x		
Lithography started		x	
Move to lithography position		x	
Drawing feature (after tip down)			x
Lithography finished		x	
Execute layer that has bias control disabled	No change in bias status		

**Table 1: Bias switching logic**

### Technical specifications

- Sample puck configuration: Insulating ABS plastic with a conducting path between the pin jack and nearest screw insert
- Internal supply type: Voltage source
- Internal supply range: 0V to +10V, switched using the InkCAD software
- Internal voltage supply accuracy: 1%
- Internal supply maximum current: 30 mA
- Internal signal rise time 0-10V: 1  $\mu$ s
- External supply voltage: 0V to 200V
- Resistance from metalized probe through tip clip to phono plug: <5 Ohm
- Resistance between DAC signal and ground at 0V: <2 Ohm
- Probe status without attached phono plug: Connected to instrument ground
- Line writing time delay between 'tip down' and 'lithography bias on': 120 ms  $\pm$  9 ms
- Line writing time delay between 'tip up' and 'rest bias on': 70 ms  $\pm$  3 ms
- Dot writing time delay between 'tip down' and 'lithography bias on': 13  $\mu$ s  $\pm$  1  $\mu$ s
- Dot writing time delay between 'tip up' and 'rest bias on': 13  $\mu$ s  $\pm$  1  $\mu$ s
- Signal delay through switch box: < 0.5  $\mu$ s
- Trigger output current protection: 100mA self-resetting thermal fuse
- Trigger output voltage protection: 15V Zener diode to ground
- Software bias control configuration: Two values, lithography bias and rest bias, can be chosen for each design layer.
- TTL trigger configuration: Use the trigger output and set lithography bias = 5V, rest bias = 0V

**Nanolnk does not guarantee lithographic feature sizes attainable with this technique due to the variety of user supplied materials.**

For more information including pricing, please contact Nanolnk Sales Department at [sales@nanolnk.net](mailto:sales@nanolnk.net) or 1-847-679-NANO.

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