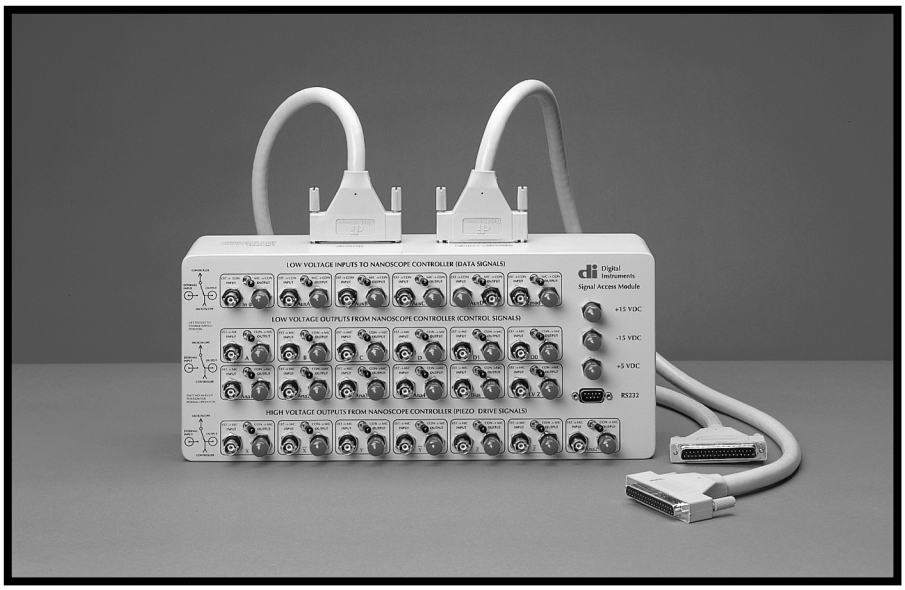
Digital Instruments

***Support Note No. 210, Rev. C***

# *NanoScope™ Signal Access Module (SAM)— Description & Use*





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# *NanoScope™ Signal Access Module (SAM)— Description & Use*

## *210.1 Description*

The NanoScope™ Signal Access Module (SAM)[1] enables SPM users to make direct connections to their microscope's electronics. For most applications, the SAM avoids disassembling the microscope, and is provided with BNC connectors which interface with most standard laboratory instruments (see Figure 210-1). Twenty-five separate SPM signals are available. Toggle switches enable the user to switch each line separately between a normal, uninterrupted configuration and an external input signal. Output BNC connectors permit monitoring of both conditioned and uninterrupted signals for use in experiments.

**IMPORTANT NOTE**: While providing maximum access to SPM electronics, the SAM also makes the unit more vulnerable to abuse. Users are cautioned that Digital Instruments assumes no responsibility for repair costs to the SPM or peripheral equipment associated with misuse of the SAM.

Signal connectors are divided into three groups:

- Low Voltage Inputs to NanoScope Controller (data signals)
- Low Voltage Outputs from NanoScope Controller (control signals)
- High Voltage Outputs from NanoScope Controller (piezo drive signals)

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| Rev. | Date | Section(s) Affected | Ref. DCR | Approval |
|---|---|---|---|---|
| Rev. C | 29MAY97 | Section 210.2 | 171 | |
| Rev. B | 05JUN96 | New formatting | N/A | |
| Rev. A | 26OCT95 | Released | N/A | |

1. The Signal Access Module functions as a "breakout box."


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In addition, the SAM also features BNC connectors for ± 15 VDC, +5 VDC and an RS232 9-pin plug. At the rear of the module are located two D-37 connectors for attachment to the microscope and NanoScope controller

Normally, the SAM is connected between the control box and microscope. If an Extender™ Electronics Module is utilized, the SAM is connected between the Extender and the controller.

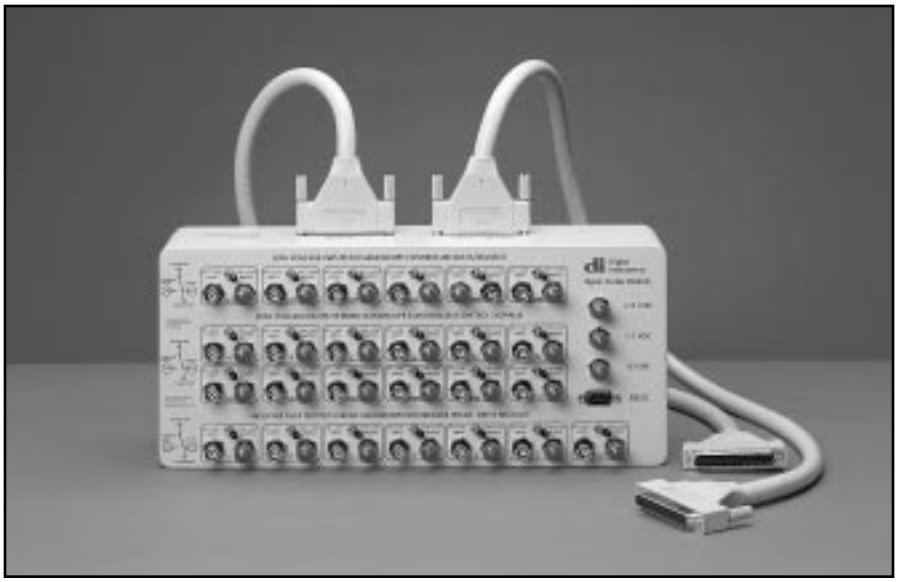


**Figure 210-1 Signal Access Module (SAM)**

The underside of the SAM features silk-screened information vital to safe, successful use of the module and should be reviewed by all users. DO NOT EXCEED MAXIMUM RATED VOLTAGES/CURRENTS OR THE MICROSCOPE AND CONTROLLER MAY BE DAMAGED! This information is provided in Appendix A of this support note.

## *Safety Precautions*

**Danger—High Voltage!**:

The bottom row of the SAM features seven output lines with maximum voltages of 220 VAC and currents up to 70 ma. The unit is shipped with all high voltage BNC connectors covered by red insulating caps. DO NOT REMOVE INSULATING CAPS UNTIL BNC CONNECTORS ARE TO BE USED! RECOVER CONNECTORS NO LONGER IN USE. Do not insert foreign objects (screwdrivers, etc.) into high voltage BNC connectors. Accidental contact with the high voltage contacts may result in serious injury.

Users are advised to disconnect the entire unit before any connections are made to high voltage lines. Be especially cautious whenever handling fluids on or around the microscope. For those imaging samples in fluid, it is recommended that fluids be kept in spill-proof squirt bottles and used sparingly. Wipe away all spilled fluids immediately and avoid spilling fluids into the microscope's imaging head.

### Protect External Equipment

A 1.0 amp fuse is wired into the 5 VDC line; all other lines are unfused. If protection of external equipment is required, it is recommended that fuses or optoisolators be utilized.

When making multiple connections between the SAM and external equipment, it is recommended that all connection cables be labeled clearly to prevent confusion. External equipment which is being modified to operate with the microscope should be modified *before* connection to the SAM.

Test all new connections and setups with a voltmeter or oscilloscope *before* connecting to the microscope to verify minimum and maximum output levels. Output levels should be compared with values listed on the underside of the box (see Appendix A) to verify that they are within safe operating limits.

### Lift Up on Toggle Switches

Toggle switches used with the SAM are designed to avoid accidental toggling—they must be pulled upward to toggle, then released (see Figure 210-2). This "locks" the toggle switch in position. DO NOT FORCE TOGGLE SWITCHES!

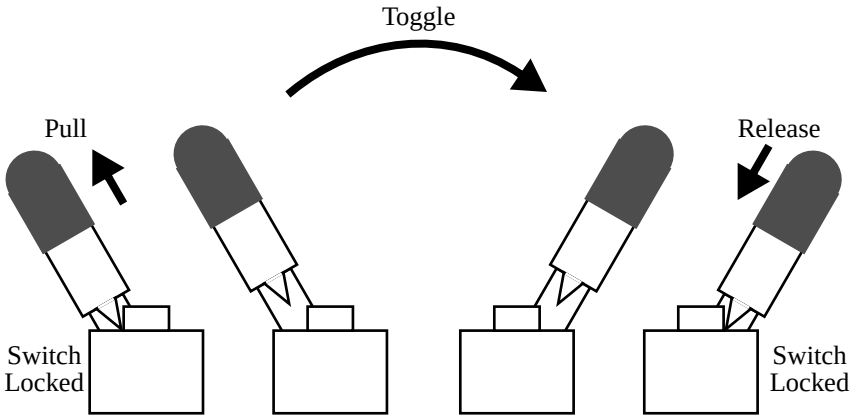



**Figure 210-2 Lift switches when toggling.**

### Do Not Remove Base

Do not remove the base of the SAM. There are no user-serviceable parts inside and a risk of high voltage shock is present. If failure of the SAM is suspected, return the entire unit to Digital Instruments for repair or replacement.

## *210.2 Installing the SAM*

1. Remove the SAM from its packing box. The packing box should contain the following items:

- SAM
- Connector Cable, D-37 type, 4-foot.
- Insulator Covers (7), red. Installed on all high voltage outputs.
- *Support Note No. 210* (this document).

2. Place the SAM in a convenient, level location between the microscope and the NanoScope controller.

3. Verify that all toggle switches on the SAM are toggled to “Output” (toggled right), then power down the SPM and NanoScope controller.

**NOTE:** Switches should be toggled to “Output” (right) during normal, uninterrupted operation.

4. If you have an Extender module the labels on the SAM will be correct if you place the SAM between the NanoScope controller and the Extender box (refer to figure below).

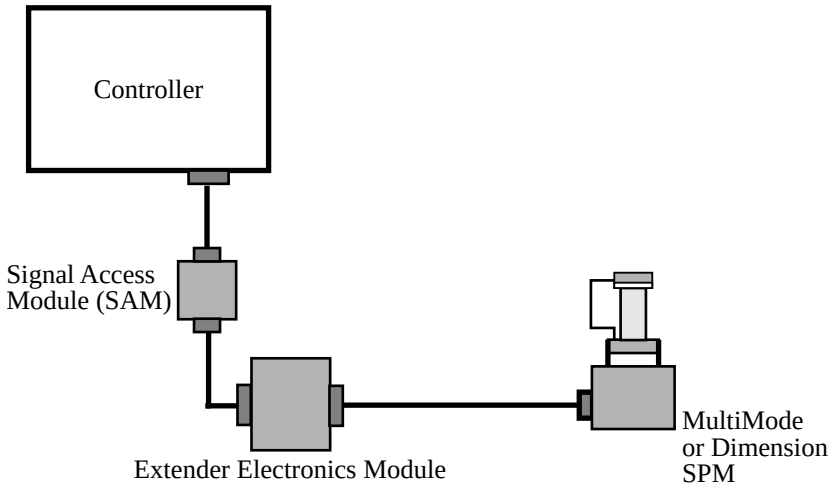



**Figure 210-3 “Normal” Configuration**

If you place the SAM between the Extender and the SPM, some of the lines will be different as noted.

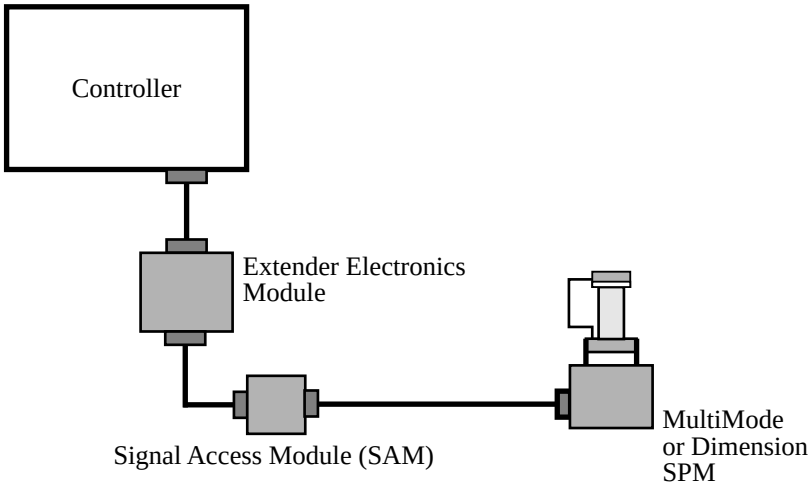



**Figure 210-4 Alternate Configuration**

| **Lines** | **Alternate[1] Signals** |
|---|---|
| AuxA | Lateral deflection |
| AuxD | STM preamp output |
| Ana1 | Piezo drive signal |
| Ana2 | Tip/Sample voltage (as selected by switches on outside of Extender Module) |
| D1 | D1 (if switch inside Extender Module is set for Dimension)<br>RMS (if switch is set for MultiMode) |

5. Repower the SPM and NanoScope controller.

1. Note: Please refer to Appendix A for the “normal” configuration signals.

## *210.3 Making Connections to the SAM*

**IMPORTANT:** Under normal conditions, external devices should not interfere with imaging electronics. However, to ensure the integrity of image data, verify that any device which is used to insert a signal into the SAM has an output impedance of ≤ 1 KΩ. Devices receiving signals from the SAM (e.g., oscilloscope) should have input impedances of ≥ 1 MΩ. If it is necessary to work beyond these impedance limits, contact Digital Instruments for instructions.

### 210.3.1 Monitoring Signals from the SAM

The SAM may be used to monitor any signal from the NanoScope controller, or any signal measured or produced by the microscope. To monitor a signal from the SAM, do the following:

1. Verify that each monitoring device to be connected has an impedance of 1 MΩ or greater.

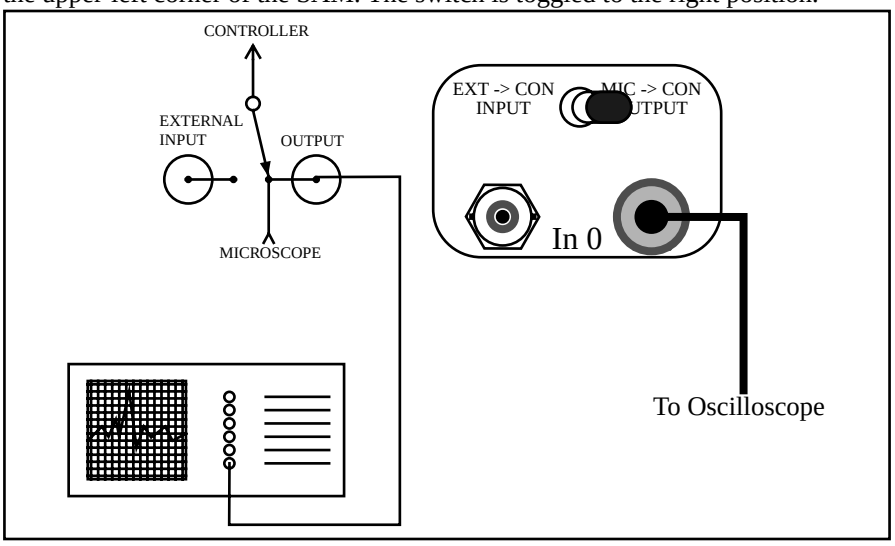
2. Make certain that all switches are toggled to the right position, except when an external signal is being inserted into the SAM (see ”Putting Signals into the SAM” below).

3. Connect all monitoring devices to the appropriate outputs using shielded BNC connectors and cables. Signals are labeled below each BNC pair. Refer also to Drawing No. ACC-BOB-8154.

**CAUTION!** High voltages are directly accessible from the SAM (bottom row). *Do not touch high voltage contacts!* Before connecting, verify that all monitoring devices to be used are compatible with the outputs by checking Appendix A or the underside of the SAM. Improperly connecting NanoScope high voltage signals can damage both the NanoScope and external devices.

### Example A. Monitoring a Feedback Signal (In 0)

The below diagram shows how to make a simple connection for monitoring feedback signals using an oscilloscope; the connection is made at the In0 connector on the upper-left corner of the SAM. The switch is toggled to the right position.




### 210.3.2 Putting Signals Into the SAM

There are two reasons for connecting external signals to the SAM: 1) to insert data signals into the NanoScope III controller; 2) to provide an external control signal or piezo drive signal to the microscope. See Examples B—F below.

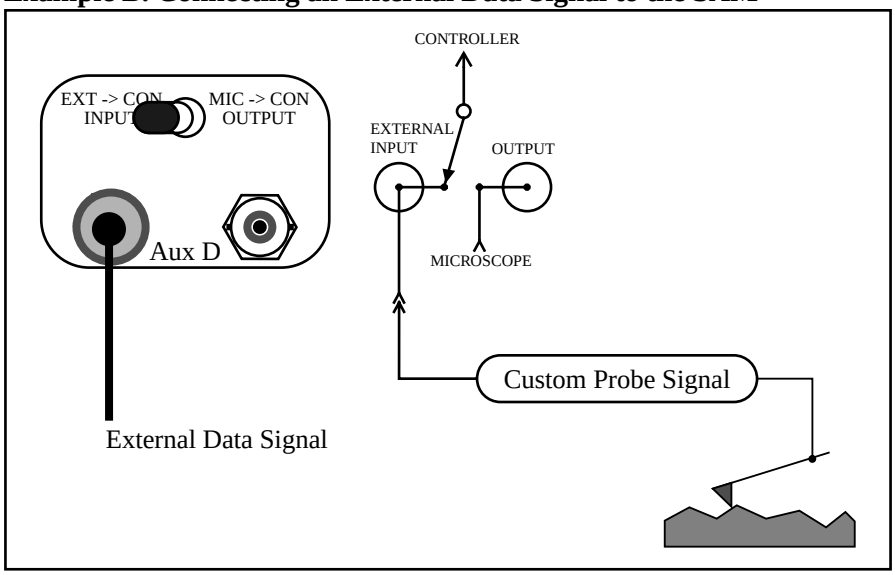
1. Verify that input devices to be connected have output impedances of less than 1 KΩ, and voltage/current outputs that do not exceed ratings provided on the underside of the SAM and in Appendix A.

2. Connect the external signal to the appropriate “Input” BNC connector. (Signals are identified below each pair of connectors and on Drawing No. ACC-BON-8154.)

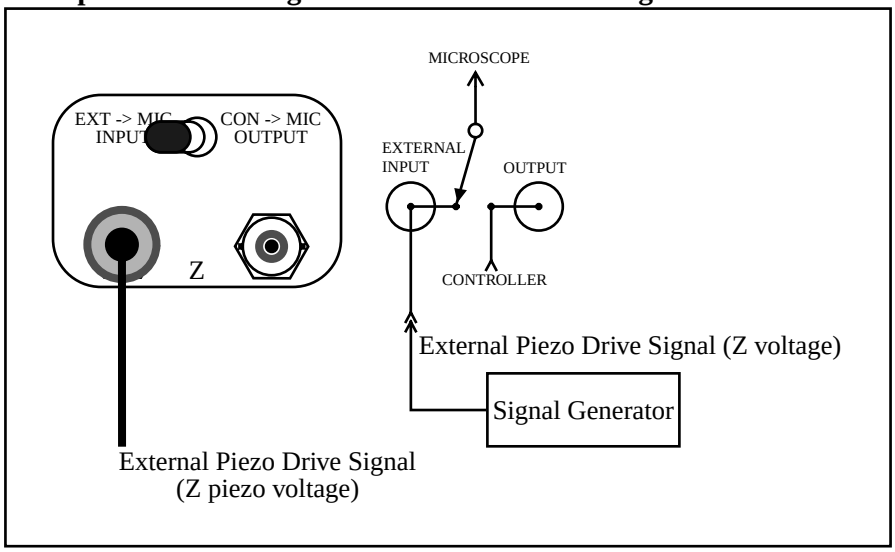
3. Toggle each selected signal’s line switch to the left, “Input” position. **Note:** toggling any switch to the left will interrupt the standard electrical connection.

4. Use inputs while staying within voltage/current limits rated on the underside of the SAM and in Appendix A. As inputs are added, closely monitor image data for any abrupt changes. If abrupt voltage changes are noted and/or if the image fails suddenly, disconnect the input line immediately—the input line may be faulty.

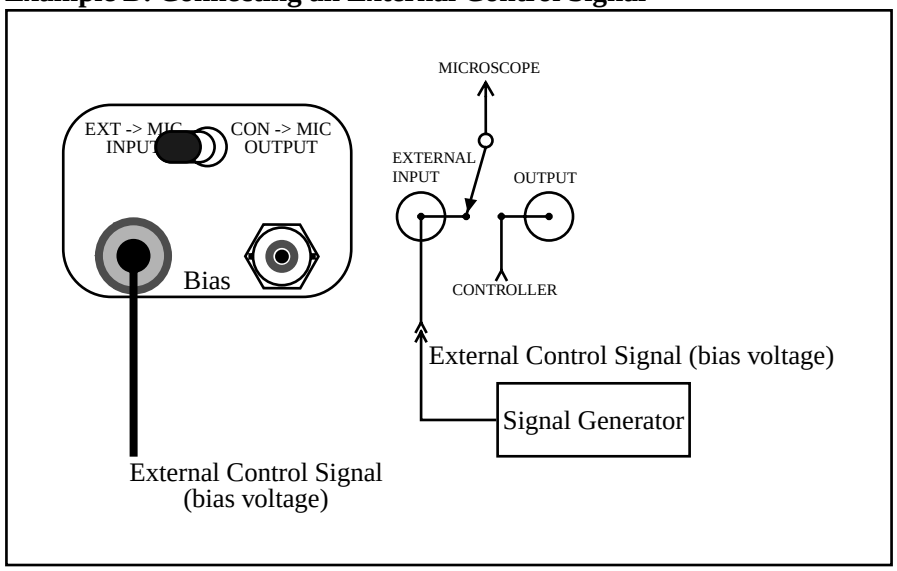
**Example B. Connecting an External Data Signal to the SAM**



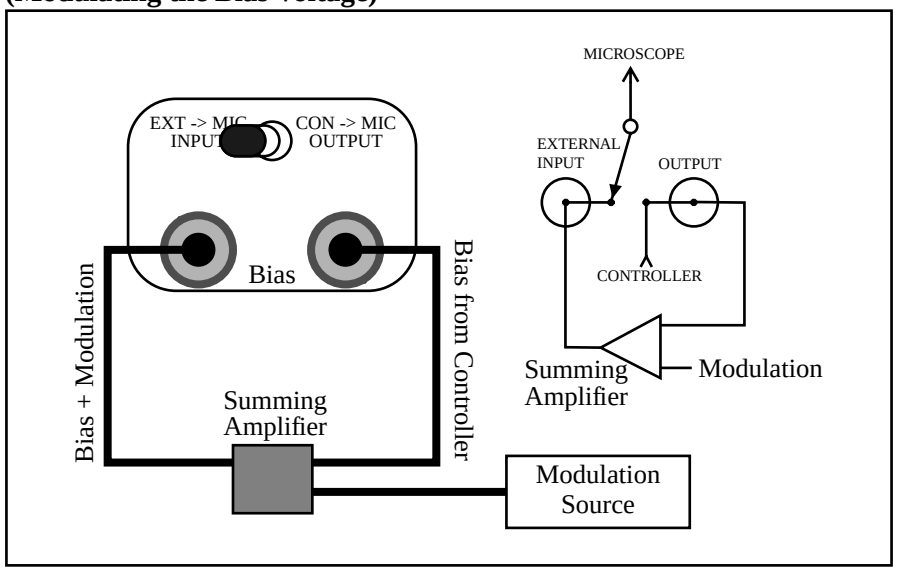

**Example C. Connecting an External Piezo Drive Signal**



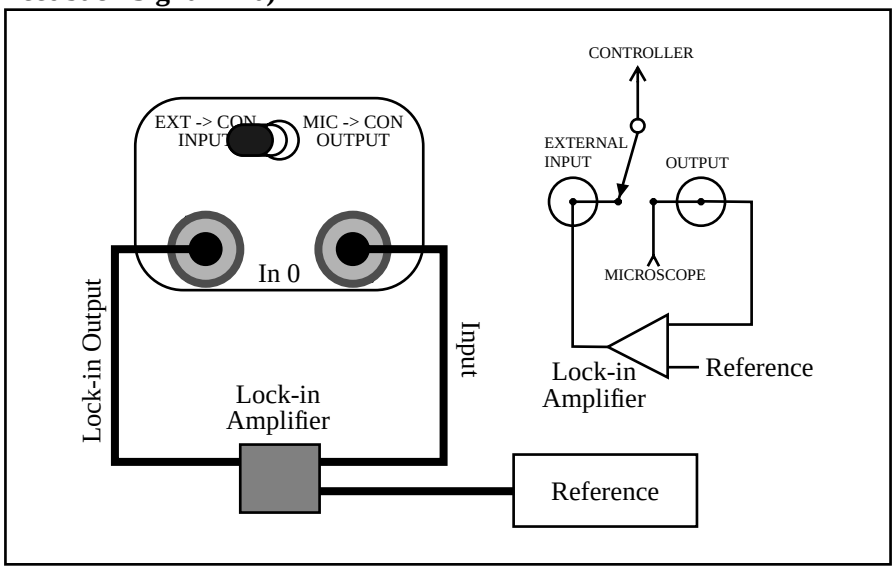
**Example D. Connecting an External Control Signal**




**Example E. Modifying a Control Signal with an External Signal (Modulating the Bias Voltage)**



**Example F. Modifying a Data Signal (E.g., Lock-in Amplifier on Feedback Signal In 0)**




## *210.4 Cautions*

Drawing No. ACC-BOB-8154 (attached) is a schematic diagram of the SAM, and illustrates its internal connections. Users may refer to this drawing when connecting external equipment. Users are advised to test all new setups using a voltmeter or oscilloscope before connecting to the SAM. Input levels should remain within limits listed on the underside of the SAM and in Appendix A.

The signal access module provides unlimited access to the NanoScope's input and output signals. This ensures maximum flexibility for customization; however, it also provides ample opportunity to damage the controller, microscope and external devices through misuse. For example, connecting a high-voltage output to a low-voltage digital output will surely destroy one or both of these output lines. To protect against such mishaps, please carefully follow the following guidelines:

1. Always check and recheck signal labels before making external connections.

2. Carefully check voltage, current and impedance limits before connecting any external device.

3. Never connect two outputs directly together.

## *210.5 Appendix A*

### Signal Access Module Connector Ratings

| SIGNAL | MAX. VOLTAGE | MAX. CURRENT | SIGNAL TYPE |
|---|---|---|---|
| In0 | ± 10 VDC | | Analog Input |
| AuxA | ± 10 VDC | | Analog Input |
| AuxB | ± 10 VDC | | Analog Input |
| AuxC | ± 10 VDC | | Analog Input |
| AuxD | ± 10 VDC | | Analog Input |
| Zmod | ± 10 VDC | | Analog Input |
| A | ± 5 VDC | 500 mA | OCL Output |
| B | ± 5 VDC | 500 mA | OCL Output |
| C | ± 5 VDC | 500 mA | OCL Output |
| D | ± 5 VDC | 500 mA | OCL Output |
| D0 | ± 5 VDC | | TTl Output |
| D1 | ± 5 VDC | | TTl Output |
| Ana1 | ± 10 VDC | 10 mA | Analog Output |
| Ana2 | ± 12 VDC | 10 mA | Analog Output |
| Ana3 | ± 10 VDC | 10 mA | Analog Output |
| Ana4 | ± 10 VDC | 10 mA | Analog Output |
| Bias | ± 10 VDC | 10 mA | Analog Output |
| LV Z | ± 12 VDC | 10 mA | Analog Output |
| X | ± 220 VDC | 70 mA | High Voltage Output |
| $\overline{X}$ | ± 220 VDC | 70 mA | High Voltage Output |
| Y | ± 220 VDC | 70 mA | High Voltage Output |
| $\overline{Y}$ | ± 220 VDC | 70 mA | High Voltage Output |
| Z | ± 220 VDC | 70 mA | High Voltage Output |
| $\overline{Z}$ | ± 220 VDC | 70 mA | High Voltage Output |
| Ana2 (HV) | | 70 mA | High Voltage Output |
| + 15 VDC | | 500 mA | Power Supply |
| -15 VDC | | 500 mA | Power Supply |
| + 5VDC | | 500 mA | Power Supply |

RS232 Connector: Pin 2 = RXD; Pin 3 = TXD; Pin 5 = GND.

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

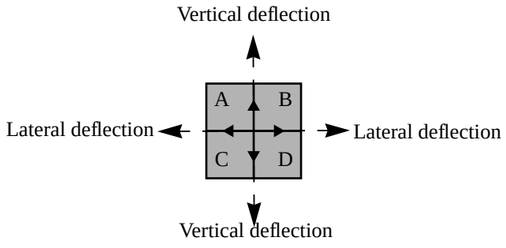
| LINES | | | MultiMode™ | | | | | | | Dimension™-series SPMs & BioScope™ | | | | | STM | | | Contact AFM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TappingMode | Contact AFM | ECAFM | STM | ECSTM | STS | Force Modulation | TappingMode | Contact AFM | STM | STS | Force Modulation | Standard | ECSTM | STS | Standard | LFM | Tip View STM | STS | ECAFM |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | RMS amplitude | Vertical deflection[a] minus setpoint voltage | | Voltage as a function of tunneling current | | | | RMS amplitude | Vertical deflection minus setpoint voltage | Voltage as a function of tunneling current | | | Voltage as a function of tunneling current | | | Vertical deflection[a] minus offset voltage | Vertical deflection[b] minus offset voltage | Voltage as a function of tunneling current | | Vertical deflection minus offset voltage |
| | | Aux A | Vertical deflection[a] | Lateral deflection (LFM)[a'] | cell current | Set by user | cell current | | | Vertical deflection[a] | Lateral deflection (LFM)[a'] | | | | Set by user | | | Set by user | Lateral deflection (LFM)[b'] | Set by user | | Cell current |
| | | Aux B | Set by user | | | Set by user | | | | See note [c] | | | | | | | | | | | | Not used |
| | | Aux C | Set by user | | | Set by user | | | | Photodiode array sum (A+B+C+D) | | | | | | | | | | | | |
| | | Aux D | Set by user. See note [e] | | cell potential | See note[e] | cell potential | | | Set by user. See note [d] | | | | | | | | | | | | Cell potential |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Setpoint voltage | | | Sample bias | | | | Setpoint voltage | | Sample bias | | | Sample bias | | | Setpoint voltage | | Sample bias | | Setpoint voltage |
| | | Ana.1 | Cantilever drive amp. | Set by user | Working electrode potential | Set by user | Tunneling tip potential | | | Cantilever Drive amp. | Set by user | | | | Set by user | | | Set by user | | | | Working electrode potential |
| | | Ana.2 LV | Configured at factory to control 1X & 8X output attenuation of final stage, but may be reconfigured using jumpers in MultiMode base.[e] | | | | | | | | | | | | Set by user | | | Set by user | | | | |
| | ± 220 VDC | Ana.2 HV | 22 X Ana.2 LV. See note [e] | | | | | | | | | | | | Set by user | | | | | | | |
| Digital Ouputs from NanoScope® | | D0 | See note[f] | line sync | cell on/off | line sync | cell on/off | | | See note [f] | line sync | | | | line sync | Cell on/off | | line sync | | | | Cell on/off |
| | | D1 | | frame sync | galv/pot | frame sync | galv/pot | | | | frame sync | | | | frame sync | galv/pot | | frame sync | | | | galv/pot |
| Motor Lines from NanoScope | | A | write strobe/ stepper motor | Stepper motor | | | | | | write strobe/ stepper motor | Stepper motor | | | | Stepper motor | | | Stepper motor | | | | |
| | | B | serial in/ stepper motor | | | | | | | serial in/ stepper motor | | | | | | | | | | | | |
| | | C | frequency load/step-per motor | | | | | | | frequency load/step-per motor | | | | | | | | | | | | |
| | | D | reset synth./ stepper motor | | | | | | | reset synth./ stepper motor | | | | | | | | | | | | |

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

a. Vertical deflection (see photodiode array-laser beam orientation below): $\frac{(A + B) - (C + D)}{A + B + C + D}$

a'. Lateral (horizontal) deflection (see photodiode array-laser beam orientation below): $\frac{(A + C) - (B + D)}{A + B + C + D}$

Photodiode orientation (MultiMode™, Dimension™-series SPMs, standard contact AFM, MFM, EFM):

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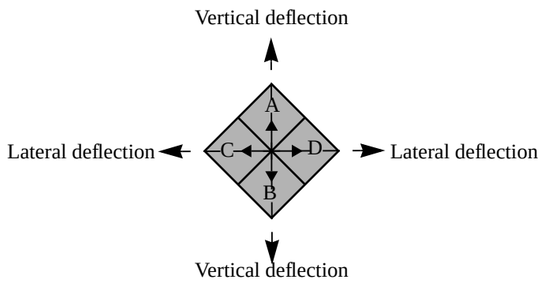
b. Vertical deflection— Contact AFM Lateral Force Microscope (LFM): $\frac{A - B}{A + B}$

b'. Lateral (horizontal) deflection— Contact AFM Lateral Force Microscope (LFM) friction measurements: $\frac{C - D}{C + D}$

Photodiode orientation (LFM head only):

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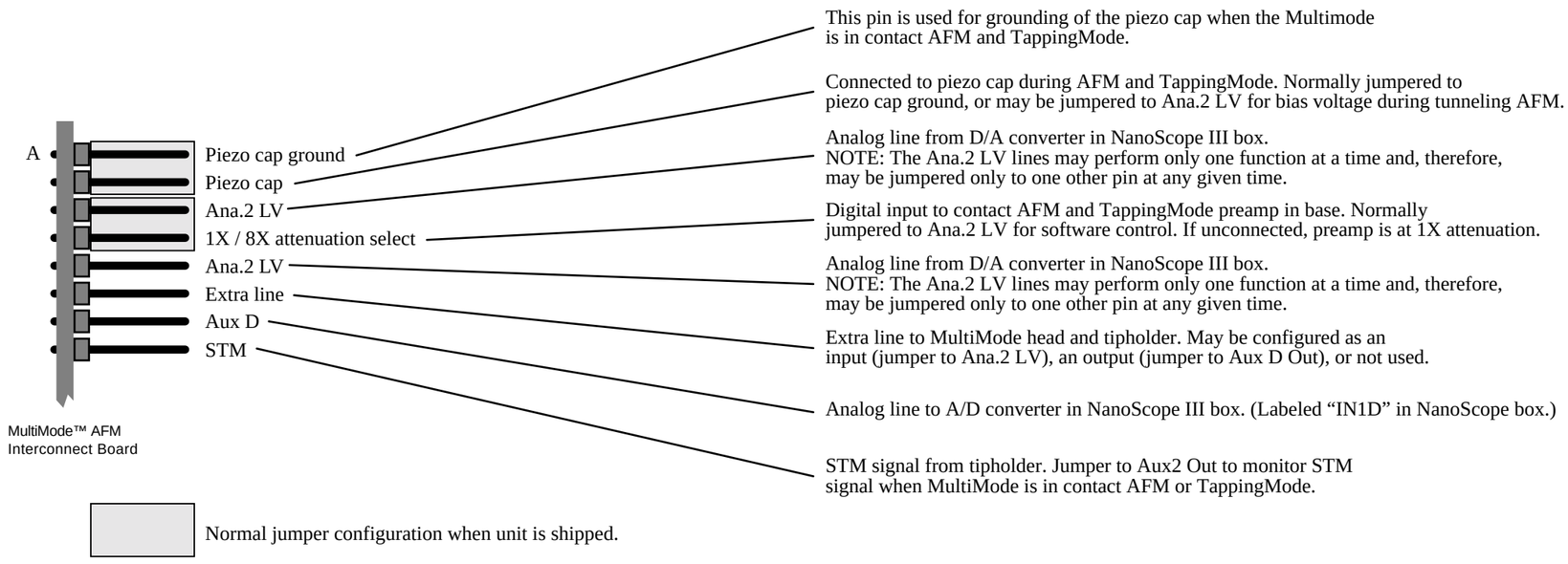
c. Some auxillary lines in Dimension-series SPMs are used for checking limit switches. Previous to engagement, the system alternates between TappingMode and contact AFM so that the LFM signal may be used to update the photodiode display.

d. Aux D connects to a jumper on the backplane that is normally jumpered to STM. Aux D may also serve as a user input.

e. MultiMode™ microscopes feature an internal interconnect board (P/N MMD-INT-1293) having jumpers. These jumpers are accessible through the opening in the bottom cover of the MultiMode base and may be reconfigured as shown here:




**NOTE:** Ana.2 HV (high voltage) is permanently set to be at 22 times (22X) the Ana.2 LV (low voltage)voltage.

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f. The function of motor lines to the MultiMode base is controlled by D0 and D1 in the following ways:

| D0 | D1 | |
|---|---|---|
| 0 | 0 | Motor lines control the engage motor. |
| 0 | 1 | Motor lines control the frequency synthesizer. |
| 1 | X | Motor and frequency synthesizer data is latched and motor lines from the NanoScope are ignored. |

**NOTE:** When motor lines control the frequency synthesizer, functions listed on chart above for TappingMode motor lines (A = write strobe; B = serial in; C = frequency load; D = reset synthesizer) are in effect.

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

| LINES | | | Interferometric AFM Detection | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manual Stage | | StandAlone™ | | Large Sample Stage (LSS) | |
| | | | Contact AFM | TappingMode | Contact AFM | TappingMode | Contact AFM | TappingMode |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | detector | | | | | |
| | | Aux A | Set by user | | | | | |
| | | Aux B | | | | | | |
| | | Aux C | | | | | | |
| | | Aux D | | | | | | |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Ground | | | | | |
| | | Ana.1 | Setpoint voltage | | | | | |
| | | Ana.2 LV | Set by user | | | | | |
| | ± 220 VDC | Ana.2 HV | Set by user | | | | | |
| Digital Ouputs from NanoScope® | | D0 | line sync | | | | | |
| | | D1 | frame sync | | | | | |
| Motor Lines from NanoScope | | A | | | Unused | | | |
| | | B | | | | | | |
| | | C | | | | | | |
| | | D | | | | | | |

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

## *Magnetic Force Microscopy (MFM) and Electric Force Microscopy (EFM) Settings*

| LINES | | | MultiMode™ | | | | Dimension™-series SPMs & BioScope™ | | | | Interferometric AFM Detection | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Manual Stage | | | | StandAlone™ | | | | Large Sample Stage (LSS) | | | |
| | | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | |
| | | | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | RMS amplitude | | | | RMS amplitude | | | | | | | | | | | | | | | |
| | | Aux A | Vertical deflection | | | | Vertical deflection[a] | | | | | | | | | | | | | | | |
| | | Aux B | Set bu user. | | | | | | | | | | | | | | | | | | | |
| | | Aux C | | | | | Photodiode array sum (A+B+C+D) | | | | | | | | | | | | | | | |
| | | Aux D | Set by user. See note [e] | | | | | | | | | | | | | | | | | | | |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Setpoint voltage | | | | Setpoint voltage | | | | | | | | | | | | | | | |
| | | Ana.1 | Cantilever drive amplitude | | | | Cantilever drive amplitude | | | | | | | | | | | | | | | |
| | | Ana.2 LV | Configured at factory to control 1X & 8X output attenuation of final Multi-Mode stage, but may be reconfigured using jump-ers in MultiMode base [e]. | | | | | | | | | | | | | | | | | | | |
| | ± 220 VDC | Ana.2 HV | 22 X Ana 2LV voltage. | | | | | | | | | | | | | | | | | | | |
| Digital Ouputs from NanoScope® | | D0 | See note [f] | | | | | | | | | | | | | | | | | | | |
| | | D1 | See note [f] | | | | | | | | | | | | | | | | | | | |
| Motor Lines from NanoScope | | A | Write strobe/Stepper motor | | | | write strobe | | | | | | | | | | | | | | | |
| | | B | Serial in/Stepper motor | | | | serial in | | | | | | | | | | | | | | | |
| | | C | Frequency load/Stepper motor | | | | frequency load | | | | | | | | | | | | | | | |
| | | D | Reset synthesizer/Stepper motor | | | | reset synth. | | | | | | | | | | | | | | | |

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

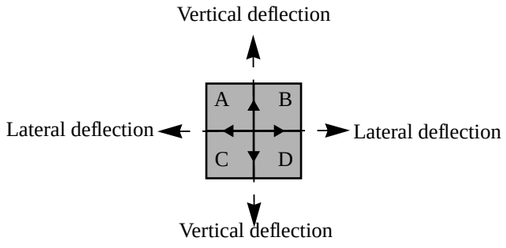
| LINES | | | MultiMode™ | | | | | | | Dimension™-series SPMs & BioScope™ | | | | | STM | | | Contact AFM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TappingMode | Contact AFM | ECAFM | STM | ECSTM | STS | Force Modulation | TappingMode | Contact AFM | STM | STS | Force Modulation | Standard | ECSTM | STS | Standard | LFM | Tip View STM | STS | ECAFM |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | RMS amplitude | Vertical deflection[a] minus setpoint voltage | | Voltage as a function of tunneling current | | | | RMS amplitude | Vertical deflection minus setpoint voltage | Voltage as a function of tunneling current | | | Voltage as a function of tunneling current | | | Vertical deflection[a] minus offset voltage | Vertical deflection[b] minus offset voltage | Voltage as a function of tunneling current | | Vertical deflection minus offset voltage |
| | | Aux A | Vertical deflection[a] | Lateral deflection (LFM)[a'] | cell current | Set by user | cell current | | | Vertical deflection[a] | Lateral deflection (LFM)[a'] | | | | Set by user | | | Set by user | Lateral deflection (LFM)[b'] | Set by user | | Cell current |
| | | Aux B | Set by user | | | Set by user | | | | See note [c] | | | | | | | | | | | | Not used |
| | | Aux C | Set by user | | | Set by user | | | | Photodiode array sum (A+B+C+D) | | | | | | | | | | | | |
| | | Aux D | Set by user. See note [e] | | cell potential | See note[e] | cell potential | | | Set by user. See note [d] | | | | | | | | | | | | Cell potential |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Setpoint voltage | | | Sample bias | | | | Setpoint voltage | | Sample bias | | | Sample bias | | | Setpoint voltage | | Sample bias | | Setpoint voltage |
| | | Ana.1 | Cantilever drive amp. | Set by user | Working electrode potential | Set by user | Tunneling tip potential | | | Cantilever Drive amp. | Set by user | | | | Set by user | | | Set by user | | | | Working electrode potential |
| | | Ana.2 LV | Configured at factory to control 1X & 8X output attenuation of final stage, but may be reconfigured using jumpers in MultiMode base.[e] | | | | | | | | | | | | Set by user | | | Set by user | | | | |
| | ± 220 VDC | Ana.2 HV | 22 X Ana.2 LV. See note [e] | | | | | | | | | | | | Set by user | | | | | | | |
| Digital Ouputs from NanoScope® | | D0 | See note[f] | line sync | cell on/off | line sync | cell on/off | | | See note [f] | line sync | | | | line sync | Cell on/off | | line sync | | | | Cell on/off |
| | | D1 | | frame sync | galv/pot | frame sync | galv/pot | | | | frame sync | | | | frame sync | galv/pot | | frame sync | | | | galv/pot |
| Motor Lines from NanoScope | | A | write strobe/ stepper motor | Stepper motor | | | | | | write strobe/ stepper motor | Stepper motor | | | | Stepper motor | | | Stepper motor | | | | |
| | | B | serial in/ stepper motor | | | | | | | serial in/ stepper motor | | | | | | | | | | | | |
| | | C | frequency load/step-per motor | | | | | | | frequency load/step-per motor | | | | | | | | | | | | |
| | | D | reset synth./ stepper motor | | | | | | | reset synth./ stepper motor | | | | | | | | | | | | |

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

a. Vertical deflection (see photodiode array-laser beam orientation below): $\frac{(A + B) - (C + D)}{A + B + C + D}$

a'. Lateral (horizontal) deflection (see photodiode array-laser beam orientation below): $\frac{(A + C) - (B + D)}{A + B + C + D}$

Photodiode orientation (MultiMode™, Dimension™-series SPMs, standard contact AFM, MFM, EFM):

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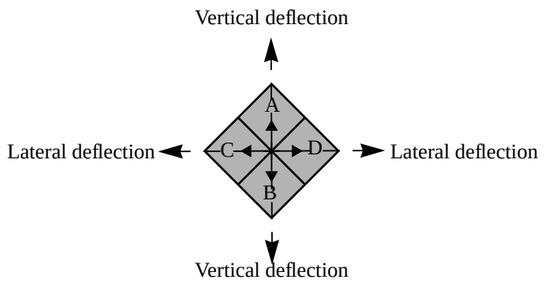
b. Vertical deflection— Contact AFM Lateral Force Microscope (LFM): $\frac{A - B}{A + B}$

b'. Lateral (horizontal) deflection— Contact AFM Lateral Force Microscope (LFM) friction measurements: $\frac{C - D}{C + D}$

Photodiode orientation (LFM head only):

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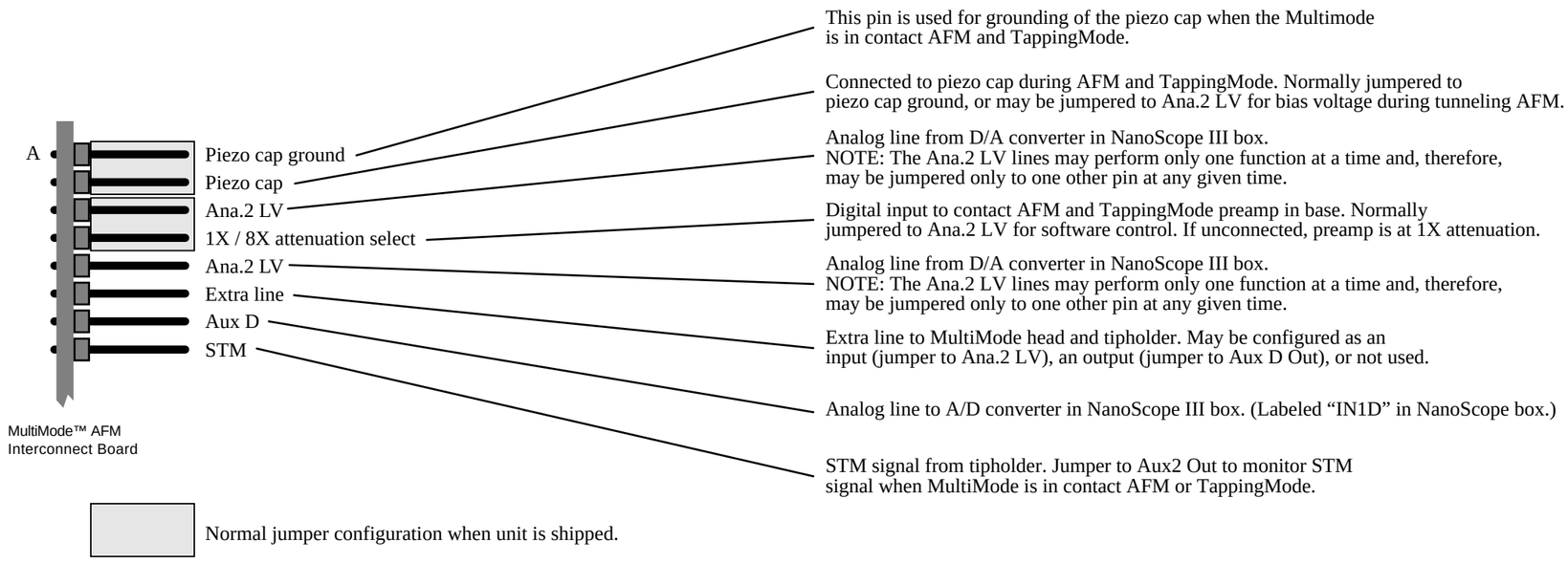
c. Some auxillary lines in Dimension-series SPMs are used for checking limit switches. Previous to engagement, the system alternates between TappingMode and contact AFM so that the LFM signal may be used to update the photodiode display.

d. Aux D connects to a jumper on the backplane that is normally jumpered to STM. Aux D may also serve as a user input.

e. MultiMode™ microscopes feature an internal interconnect board (P/N MMD-INT-1293) having jumpers. These jumpers are accessible through the opening in the bottom cover of the MultiMode base and may be reconfigured as shown here:




**NOTE:** Ana.2 HV (high voltage) is permanently set to be at 22 times (22X) the Ana.2 LV (low voltage)voltage.

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f. The function of motor lines to the MultiMode base is controlled by D0 and D1 in the following ways:

| D0 | D1 | |
|---|---|---|
| 0 | 0 | Motor lines control the engage motor. |
| 0 | 1 | Motor lines control the frequency synthesizer. |
| 1 | X | Motor and frequency synthesizer data is latched and motor lines from the NanoScope are ignored. |

**NOTE:** When motor lines control the frequency synthesizer, functions listed on chart above for TappingMode motor lines (A = write strobe; B = serial in; C = frequency load; D = reset synthesizer) are in effect.

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

| LINES | | | Interferometric AFM Detection | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manual Stage | | StandAlone™ | | Large Sample Stage (LSS) | |
| | | | Contact AFM | TappingMode | Contact AFM | TappingMode | Contact AFM | TappingMode |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | detector | | | | | |
| | | Aux A | Set by user | | | | | |
| | | Aux B | | | | | | |
| | | Aux C | | | | | | |
| | | Aux D | | | | | | |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Ground | | | | | |
| | | Ana.1 | Setpoint voltage | | | | | |
| | | Ana.2 LV | Set by user | | | | | |
| | ± 220 VDC | Ana.2 HV | Set by user | | | | | |
| Digital Ouputs from NanoScope® | | D0 | line sync | | | | | |
| | | D1 | frame sync | | | | | |
| Motor Lines from NanoScope | | A | | | Unused | | | |
| | | B | | | | | | |
| | | C | | | | | | |
| | | D | | | | | | |

# *Appendix A, Support Note 210, Rev. C Microscope Product-Mode Signal Matrix*

## *Magnetic Force Microscopy (MFM) and Electric Force Microscopy (EFM) Settings*

| LINES | | | MultiMode™ | | | | Dimension™-series SPMs & BioScope™ | | | | Interferometric AFM Detection | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Manual Stage | | | | StandAlone™ | | | | Large Sample Stage (LSS) | | | |
| | | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | | Without Extender™ Electronics Module | | With Extender™ Electronics Module | |
| | | | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM | MFM | EFM |
| Analog Inputs to NanoScope® ± 10VDC | | In 0 | RMS amplitude | | | | RMS amplitude | | | | | | | | | | | | | | | |
| | | Aux A | Vertical deflection | | | | Vertical deflection[a] | | | | | | | | | | | | | | | |
| | | Aux B | Set bu user. | | | | | | | | | | | | | | | | | | | |
| | | Aux C | | | | | Photodiode array sum (A+B+C+D) | | | | | | | | | | | | | | | |
| | | Aux D | Set by user. See note [e] | | | | | | | | | | | | | | | | | | | |
| Analog outputs from NanoScope® | ± 10 VDC | Bias | Setpoint voltage | | | | Setpoint voltage | | | | | | | | | | | | | | | |
| | | Ana.1 | Cantilever drive amplitude | | | | Cantilever drive amplitude | | | | | | | | | | | | | | | |
| | | Ana.2 LV | Configured at factory to control 1X & 8X output attenuation of final Multi-Mode stage, but may be reconfigured using jump-ers in MultiMode base [e]. | | | | | | | | | | | | | | | | | | | |
| | ± 220 VDC | Ana.2 HV | 22 X Ana 2LV voltage. | | | | | | | | | | | | | | | | | | | |
| Digital Ouputs from NanoScope® | | D0 | See note [f] | | | | | | | | | | | | | | | | | | | |
| | | D1 | See note [f] | | | | | | | | | | | | | | | | | | | |
| Motor Lines from NanoScope | | A | Write strobe/Stepper motor | | | | write strobe | | | | | | | | | | | | | | | |
| | | B | Serial in/Stepper motor | | | | serial in | | | | | | | | | | | | | | | |
| | | C | Frequency load/Stepper motor | | | | frequency load | | | | | | | | | | | | | | | |
| | | D | Reset synthesizer/Stepper motor | | | | reset synth. | | | | | | | | | | | | | | | |