



### General specifications.

The **SPMagic R2** is a low-cost, compact solution intentionally designed as an open, customizable SPM Control System.

**SPMagic R2** consists of a computer driven SPM controller equipped with both AFM and STM signal conditioning electronics, capable of implementing further measuring techniques such as SNOM or others.

The system can be connected with one of our precision high voltage amplifiers suitable for interfacing home-built as well as commercial measuring heads.

The system is a consistent instrument which can be used as-it-is (just turn on the power and go !), as well as in a variety of different setups, since all signals are available at the front panel and can be used to customize the setup, even in conjunction with add-on external equipments.

The software allows the control of all the available features and directly drives the data acquisition. Extra analog input channels are available for further improving the experimental capabilities.



The **SPMagic R2** controller provides different types of XYZ scan signals and can therefore be easily connected with many types of High Voltage amplifiers, either chosen among our models or from third party producers.

In particular, the system provides outputs directly compatible with most piezoactuator Companies' standards. Among them we can quote PiezoSystemJena, Physik Instrumente, Staveley sensors Inc and others.

We produce our T-100, T-400, T-700 SPM-devoted HV amplifiers as well as many other models suitable for special piezoelements.

## Product highlights.

- ◆ All available signals are present at the front panel, which enables easy and fast customization of the experimental setup.
- ◆ Full 18/16 bit data acquisition electronics. The AD/DA sections of the controller are embedded in a PCI card which also provides the system with synchronization and digital I/O signals.
- ◆ Positioning 16 bit DAC technology plus 16 bit scan DAC allows to maximize the scanning resolution at any scan dimension.
- ◆ The controller is fully software-controlled. No front panel switches and pots ! Just open the user interface window or pop up panel dedicated to a certain section and perform all settings and regulations from there. New software releases will be free and downloadable from our web site. Our company ensures that support on the driving software will be continued for years.
- ◆ The flexible software control allows easy and fast setting even when external devices are used for particular experimental setups. In these cases, choose the correct plugs at the front panel, connect them to your equipment and easily switch the signal path from the software program.
- ◆ An AFM measuring head can be included; it is a compact and flexible solution featuring a four quadrant detection system together with an intensity-regulable laser diode. Plane scan ranges vary from 1x1  $\mu\text{m}$  up to 100x100  $\mu\text{m}$ . Custom ranges are available upon request, just specify the range you need at the order time !
- ◆ The system allows contact deflection, topography and torsion measurements, as well as tapping mode imaging with the integrated **LetItTap** module, force-distance curve and maps. Specific additional measurements can be easily setup.
- ◆ STM measurements are performed using an external, shielded, high precision lin/log current preamplifier, directly connected to the controller STM input.

## System details.

Controller	
Dimensions	19" x 3U x 500mm
Weight	5 kg
Voltage	230 VAC $\pm$ 5%, 50-60 Hz (115 VAC upon request)
Power consumption	<20 W
Connections	
<ul style="list-style-type: none"> <li>• Measuring head, standard 25 pin D-type</li> <li>• Power supply input, fuse protected</li> <li>• Computer interface, 2 x high density SCSI-III 68 way</li> <li>• Serial Interface control signals for device expansions (analog supply included), 15 pin D-type</li> <li>• BNC inputs:               <ul style="list-style-type: none"> <li>▪ external feedback signal 1 (suitable for SNOM and other techniques)</li> <li>▪ external feedback signal 2</li> <li>▪ external feedback signal 3</li> <li>▪ aux analog input channel 1, <math>\pm</math>10V vs. GND</li> <li>▪ aux analog input channel 2, <math>\pm</math>10V vs. GND</li> <li>▪ z-axis piezo actuator modulation</li> <li>▪ external feedback connection</li> <li>▪ AFM conducting probe signal</li> </ul> </li> <li>• BNC outputs:               <ul style="list-style-type: none"> <li>▪ feedback output monitor</li> <li>▪ V bias</li> <li>▪ AFM deflection (T-B) signal monitor</li> <li>▪ AFM torsion (L-R) signal monitor</li> <li>▪ four quadrant photocell sum signal</li> <li>▪ AFM tapping signal monitor</li> <li>▪ AFM tapping RMS signal</li> <li>▪ AFM tapping phase signal</li> <li>▪ AFM tapping modulation signal</li> <li>▪ AFM tapping TTL modulation signal</li> <li>▪ STM log signal</li> <li>▪ STM lin signal</li> <li>▪ STM tunneling current monitor</li> <li>▪ Auxiliary DAC output</li> <li>▪ Scan X+, <math>\pm</math>10V vs. GND</li> <li>▪ Scan X-, <math>\pm</math>10V vs. GND</li> <li>▪ Scan Y+, <math>\pm</math>10V vs. GND</li> <li>▪ Scan Y-, <math>\pm</math>10V vs. GND</li> <li>▪ Z signal, <math>\pm</math>10V vs. GND</li> <li>▪ Scan X, 0÷10V or -2÷12V (for Physik Instrumente piezo drivers) vs. GND</li> <li>▪ Scan Y, 0÷10V or -2÷12V (for Physik Instrumente piezo drivers) vs. GND</li> <li>▪ Scan Z, 0÷10V or -2÷12V (for Physik Instrumente piezo drivers) vs. GND</li> <li>▪ Z DAC output monitor</li> </ul> </li> </ul>	
Resolution	
AD converter	16 channels, 16 or 18 bit
DA Scan X-Y converters	16 bit
DA Positioning X-Y converters	16 bit
DA Z (force-distance and I-V curves)	16 bit
Laser intensity regulation DAC	12 bit, 0 to 5 mW

## STM

We offer two STM preamplifiers models, respectively indicated for tip-grounded and for sample-grounded experimental setups. Both models allows setting the bias voltage between tip and sample through a software driven 12 bit stable digital to analog converter and feature a gain of  $10^8$  (i.e. 1nA input current produces a 100 mV output voltage). The preamplifiers are embedded in a metal chassis for noise immunity and connect to the Controller by means of a single cable. Our preamplifier's input current range goes from 30 pA to 30 nA in log mode and from 30 pA to 10 nA in linear mode. The equivalent output noise with no input is 4 pA RMS. The following plot shows the frequency response of the preamplifiers with 1nA input current. ElbaTech offers also optional current preamplifiers with different features to allow particular measurements. Among them we can quote a BEEM-oriented low-current precision current-to-voltage converter with a gain of  $10^{11}$  (BEEM is Ballistic Electron Emission Microscopy). These preamplifiers are usually too slow for STM operation but are best indicated for specific purposes, therefore they should be used accordingly to particular User's needs.

## Data acquisition

Imaging mode:

- 5 independent and selectable channels acquired during scanning
- image is acquired by rastering, therefore two images per scan are available (forward and backward)
- image resolution ranges from 64x64 up to 512x512 pixel, at 16 or 18 bit
- scan frequency per line 40 Hz max
- selection area is defined by user-friendly drag operations on the user interface
- zooming in and out available

Signal mode:

- 12 independent channels can be acquired
- during tip-sample approach, all the necessary signals are monitored and displayed

Force-distance and I-V modes:

- the system drives the piezo tube while acquiring input data
- eventual modulation signals can be superimposed to the piezo driving signal

## Feedback control

Native feedback is analog, fully digitally-controlled. External feedback systems can be easily interfaced to the instrument.

The feedback implements a modified PI(D) controller with additional bandwidth control.

Feedback controls:

- input signal setpoint
- proportional gain
- integral gain
- derivative gain
- working bandwidth selection

Additional controls for system customization:

- feedback input signal sign (positive/negative)
- feedback input signal source (choose one of available 8 channels)
- feedback output sign (direct/reverse)
- feedback controller (internal/external)
- HV amplifier (on/off)

## Personal computer

Included as integral part of the instrument, it can be configured also upon the user needs. Typical features are: CPU Pentium, Athlon or Celeron, system clock 3 GHz or higher, 256 Mb RAM, 40 Gbyte hard disk, 17" Monitor, keyboard, mouse, CD-ROM 52X and Microsoft Windows XP operating system.

The PC is delivered with the driving software and the data acquisition card installed and configured.

## Operating modes

### STM:

- Constant current mode
- Constant height mode
- I-V spectroscopy

### AFM:

- Constant height mode
- Constant force mode
- Lateral force mode
- Tapping mode
- Phase imaging mode
- Force-distance spectroscopy

### OTHER:

Since SPMagic R2 is a real flexible controller, advanced imaging techniques can be easily set up. Towards this end the User can utilize all the signals available at the front panel and the related selection functions in the software. Among these advanced techniques we can quote:

- SNOM
- Kelvin Probe Microscopy
- Magnetic Force Microscopy
- Conductive AFM,
- Phase-distance
- generic signal-distance curves
- etc...

NOTICE: specifications subject to change without notice.