Components for Surface Analysis

Nanonis SPM Control System

The Expandable Engine for Your SPM Project

Features

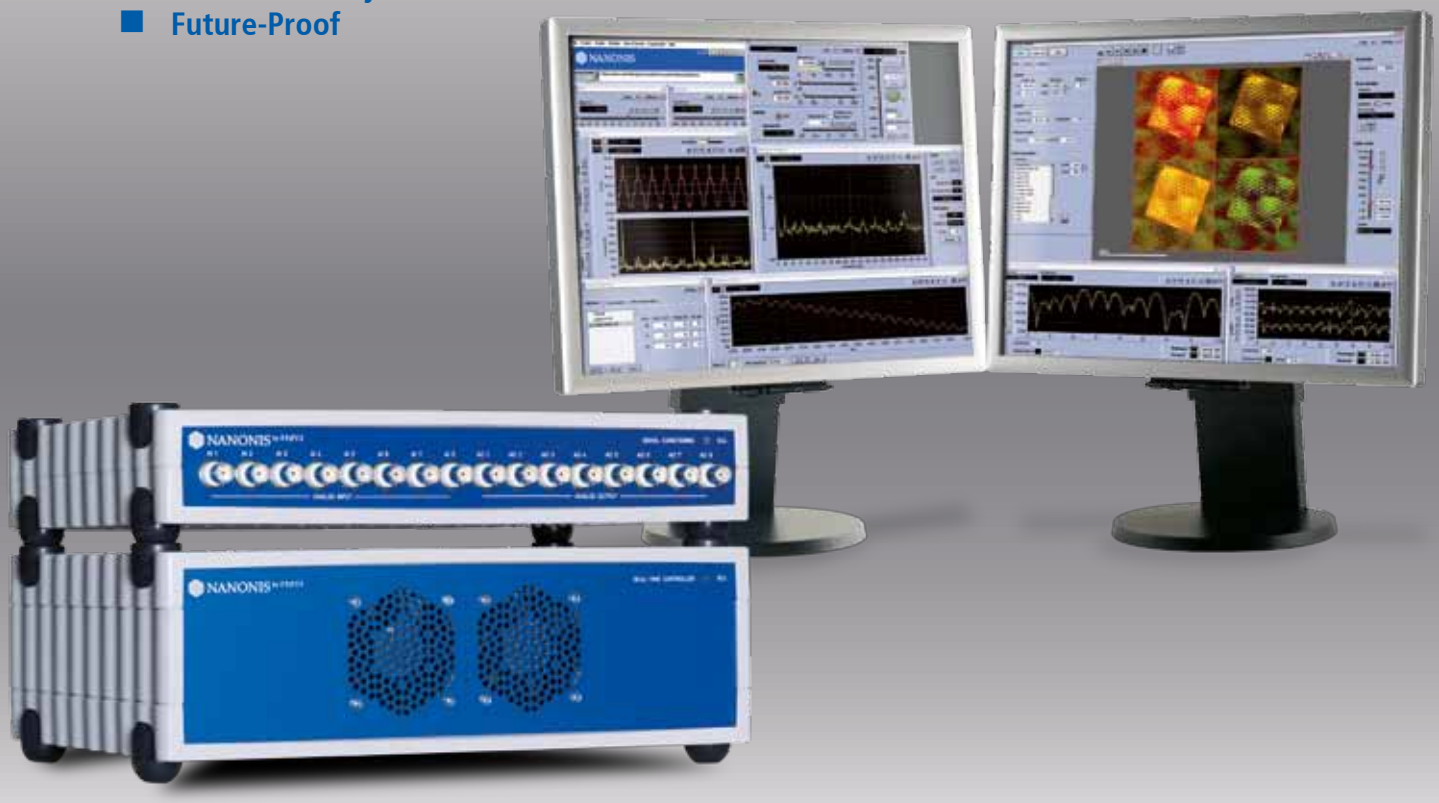
- 24 Signal Channels
- Lowest Noise and Highest Resolution
- Highly Configurable Z-Controller
- Interactive Scan Control
- Multiple Desktop
- Advanced 2-D and 3-D Spectroscopy
- Manipulation and Lithography
- Powerful and Clear User Interface
- Spectrum Analyzer and Oscilloscope
- All Signals and Parameters in Real World Units
- Works with any SPM
- Future-Proof

Outstanding

- Flexibility
- Performance
- Reliability

and Easy to Use

NANONIS



The Base Package of the Nanonis Control System provides the full functionality for basic SPM applications. From signal conditioning and AD/DA conversion to real-time signal processing and the graphical user interface, the Nanonis Base Package provides a fundamental framework that can be adapted and extended with a range of add-on modules. All basic processes such as z-control, scan-control, data acquisition, atomic manipulation, lithography and spectroscopy are included, allowing easy control of elementary STM and AFM operations.

Fully Digital System

All analog signals are converted immediately and internal processing is fully digital. This has become possible only recently with the latest advances in the performance of processors and AD/DA converters.

The advantages are:

- The system is very flexible and scalable.
- Software adaptations are all that is needed for rapid custom developments.
- Digital signal links are immune to noise, which is crucial for SPM applications.
- It has removed the limitation of range and resolution, which was a drawback when linking systems with analog signals was common.

24 Signal Channels

The generic analog interface provides 24 live signals: 8 outputs, 8 inputs and 8 internal signals. This allows connection of signals including bias voltage, tunneling current, deflection, x, y, z, external lock-ins etc. The software displays all electronic signals as real world numbers in floating-point representation, with assigned SI units for immediate quantitative results.

Signal Analysis and Monitoring

All signals can be inspected with the FFT spectrum analyzer, signal charts, oscilloscope or signal history. Such fully digital and integrated software instruments are much more efficient in use, less invasive, better in performance and lower in cost than their external counterparts. This is of great value for optimizing the experimental setup, eliminating disturbances and thus improving the quality of the scientific results.

High Resolution AD/DA Conversion

"There is plenty of room at the bottom", said Richard Feynman when he described his vision of the science that led to nanotechnology. Enormous resolution is required to reveal the smallest features, while maintaining an acceptable sample range. The Nanonis system employs sophisticated digital filtering, oversampling and dithering techniques to provide the highest resolution. The patented hrDAC™ technology turns the 16-bit DA converters into real 22-bit devices which would fill up a full board and cost ten times as much in a traditional approach. There is no need to switch gains and co-ordinates are absolute over the full range. Nanonis is pushing the limits for high resolution scanning.

Interactive Scan Control

The control system for a scanning probe microscope is like a cockpit and the pilot needs to be supported in all his maneuvers on the flight through the nano-world. The scan control module is interactive and dynamic. It is possible to zoom-in on acquired data, paste scanned data to the background for reference and display different channels in multiple windows. The motion of the tip is visualized in real-time. In summary, this system is designed to be a pleasure to use, in line with our promise: Free to explore and discover.

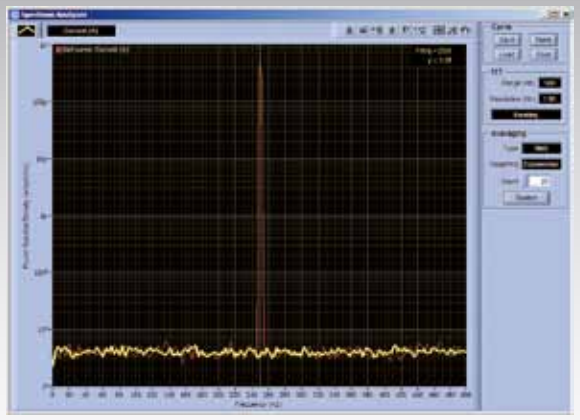
Versatile z-Controller

The distance between tip and sample can be controlled by any signal or combination of signals. The quantitative parameters allow the application of control theory models and yield a further understanding of tip-sample interaction. The user-configurable z-controller allows on-the-fly switching between settings such as input signal and feedback parameters.

Prepared for the Future: The LabVIEW Programming Interface

Competitive advantage in research is often based on the modification of an instrument that allows the researcher to perform experiments in a way nobody else has done before him. This is where our LabVIEW Programming Interface steps in - to give you the building blocks to design your own experiment.

The LabVIEW programming interface consists of libraries to access the controls and functions of the graphical user interface. It is used to automate experiments, sequences, calibration routines and experimental procedures. Polling of parameters and signals at high rates allows for supervision and alarm settings, etc. Instead of using a simple scripting language, the Nanonis System provides full access to all the features provided by LabVIEW: graphs, database access, convenient data handling, GPIB/RS232/USB access to other instruments, signal analysis functions and much more.



Add-on Modules

- OC4: digitally integrated PLL
- Lock-in Detector for all channels
- Kelvin Controller: AM & FM modes
- Atom tracking
- High voltage amplifiers and Piezo Motor Drivers
- Adaptation kits for commercial microscopes
- Interferometer Controller

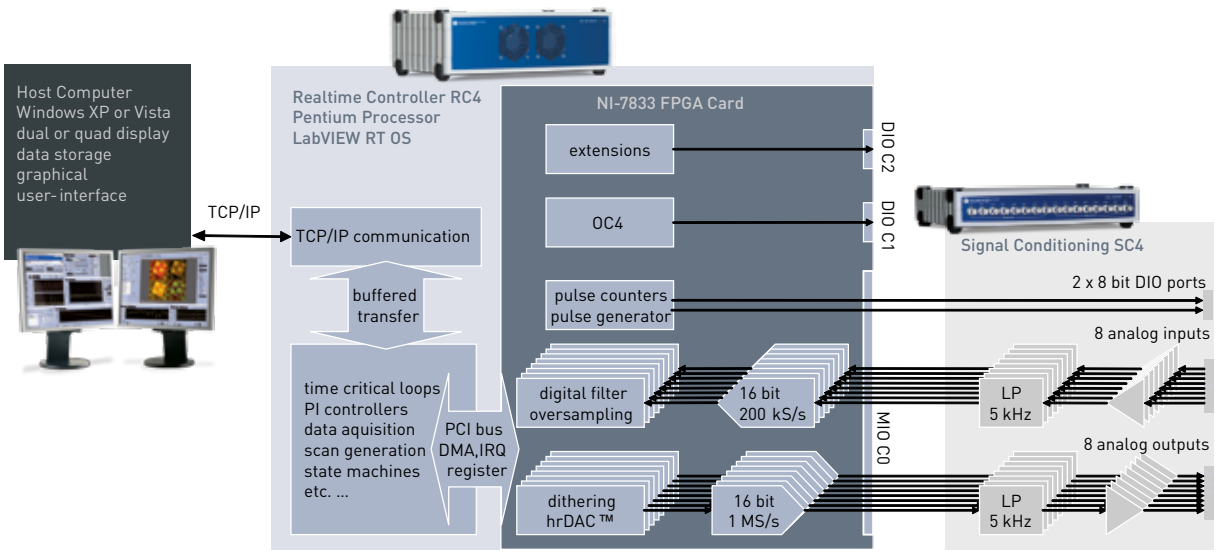
Advanced 2D and 3D Spectroscopy

Advanced spectroscopy modules provide a set of flexible routines for experiments on a point, line, grid, or a cloud of points:

- Bias spectroscopy
- z-spectroscopy
- Generic sweep: any output or parameter can be swept while any number of other selected channels are recorded
- User-defined experiment written in LabVIEW

High Reliability

The Nanonis system has a proven track record of reliability, running for months without re-boot in labs all around the world. SPM experiments are complex and do not always work on the first try. A reliable control system provides the safety that it will not fail just as a complicated experiment is progressing well.



General	
Scope of delivery	Real-time controller RC4, signal conditioning SC4, software and license, unlimited updates and support for one year, host computer (opt.)
Cases	Stackable benchtop cases, Wavetronics, rack mount kit available
Operating temp.	+5° C to +40° C
Compliance	CE
Warranty	One year parts and labor on defects in material and workmanship
Documentation	User manual for hardware and installation, printed user manual for graphical user interface, online help
RC4	
Dimensions, weight	32.5 x 28 x 12 cm, 4.5 kg
Power	Universal power supply, max 60 W
Components	Pentium mobile 2 GHz, 1 GB ram, 40 GB HD, 2 PCI slots, ethernet adapter
Operating system	National Instruments Real-Time OS
I/O card	NI-FPGA RIO (PCI-7831R)
SC4	
Dimensions, weight	32.5 x 28 x 7 cm, 3.6 kg
Power	100 V - 240 V, 50 - 60 Hz, 10 W, automatic switching, toroidal transformer, linear regulated
Ground	100 kΩ AGND to chassis, decoupled from RC4
Analog Inputs	
Hardware interface	8 x BNC connectors, differential
Diff input volt. range	±10 V
Diff input resistance	100 kΩ
Analog bandwidth	DC - 5 kHz, 4th order Butterworth low-pass filter
AD converter	16-bit, no missing codes, 200 kS/s
Effective resolution	20-bit @ 10 kS/s, 24-bit @ 100 S/s (oversampling)
Analog input noise	‹ 15 nV / sqrt(Hz)
Converter noise	‹ 2 µV / sqrt(Hz)
Measurement noise	‹ 140 µV rms @ 10 kS/s, ‹ 45 µV rms @ 1 kS/s
Analog Outputs	
Hardware interface	8 x BNC, referenced to AGND
Output voltage	±10 V into 2 kΩ, (0 to 10 V per dip switch per channel)
Output resistance	‹ 1Ω, short circuit safe
Analog bandwidth	5 kHz, 4th order Butterworth low-pass filter
DA converter	16-bit, monotonic, 1 MS/s
Effective resolution	22-bit, patented hrDAC™ technolgy with active glitch compensation
Noise density	‹ 350 nV / sqrt(Hz)
Output noise	‹ 30 µVrms, ‹ 150 µVpp (DC - 1 MHz)
Digital Lines and Pulse Counter	
Ports	2 x 8 lines on two sub-D9 female
Direction	Input or output for each line
Signal	3.3 V TTL, max 5mA per line
Pulse counters	2, up to 40 MC/s
Coarse Positioning and Auto Approach	
Types	Slip stick piezo drive, beetle type, stepper motor, DC motor
Interfaces	Digital port, serial, USB, GPIB, ethernet etc.
Auto approach	Different protocols, configurable, programmable with programming interface
Graphical User Interface	
Operating system	Windows XP/Vista/7
Min. requirements	Pentium 2 GHz or equiv., 2 GB Ram, 40 GB HD, two 19'' Monitors with at least 1280 x 1024 pixels
License	Unlimited in time, bound to RC4
Documentation	Online help, F1 for context sensitive help, tip strips for each control element, printed software operation manual
Load & save settings	For every session directory, settings, parameters and screen layout

Signals & Analysis	
Signals	24 live signals: 8 inputs, 8 outputs and 8 internal signals
Data transfer	Via TCP/IP, 1 kS/s default, up to 10 kS/s
Representation	32-bit floating point, real world physical units
Oscilloscope	DC, rms and peak-peak measurements, triggering by level or manual
Spectrum analyzer	Power spectral density in physical units (e.g. A / sqrt(Hz))
Long term spectrum	Power spectral density vs time as gray-scale plot
Signal charts	Continuously rolling charts with adjustable speed
Long term chart	Record signals over days
Signal history	All 24 signals in memory for the last minute
z-Controller	
Algorithm	Digital PI controller, anti wind-up, bump-less start and stop
Control bandwidth	Up to 2 kHz (3 dB point of closed-loop transfer function)
Control signal	Any of the 24 signals and elementary operations thereof (+, -, *, /)
Preprocessing	Abs, log, bipolar
Controller switching	On-the-fly, from a predefined set of controller settings
Param. adjustment	Real-time interactive, physical units, logarithmic or linear slider scales
SafeTip™	User-definable condition on any signal or combination thereof
TipLift™	Z-offset after switching the controller off
Smooth-off	Averaging z-position for reproducible hold of tip-sample distance
Scan Control	
Aquisition channels	1 - 24 forward and backward
Scan frame	Real-time interactive, mouse definable, also non-square
Resolution	32 x 32 up to 8192 x 8192, also non-square pixels
Scan speed	Max. 10 kHz pixel frequency, max. 100 lines/second; const time / line or const surface speed, diff. forward and backward speed
Scan modes	Single: up & down, continuous: up, down & bounce, auto save
File format	Documented, example load routines, SPIP, Gwyddion, WSxM, MATLAB
Visualization	Tip position in real-time, adjustable color table, paste scanned image to background for reference
Scan data display	Up to 7 windows with different views for zoom, channel, color etc.
Display data proc.	None, slope subtract, slope and av. subtract, differentiate
Line scan monitor	Display up to 4 last scan lines, forward and backward scan
Slope compensation	Real-time, adjustable in degrees, smooth transitions
Drift compensation	Linear in 3 dimensions
Generic Sweeper	
Sweep channels	Outputs, setpoints, div. parameters
Acquisition channels	24 signals, system parameters
Samples per curve	32 - 1 M
Visualization	Real-time during acquisition
Timing	Settling time and acquisition time (1 ms - 10 s)
Spectroscopy	
Acquisition channels	1 - 24, forward and backward
Sweep channels	Bias, z
Data samples	32 - 1M (per curve)
Timing	Z-hold av., initial settling time, settling time, acquisition time, slew rate, etc. 100 µs resolution, up to 10 s
Multi-curve av.	With z-control in between
Spectroscopy on a Grid or Line	
Grid	Rectangular, min. 4 x 4, max. limited by 2 GB total data file
File format	ASCII for each curve or binary for total grid, documented file format, file browser & example load routines
Experiments	Bias- or z-spectroscopy, generic sweeper or any self-programmed routines with LabVIEW interface
Data aquired	Topography, set of config. parameters for every point, spectroscopy data
LabVIEW Programming Interface	
Scope	Library of VI's to control elements of the graphical user-interface
Connection	Via TCP/IP to VISA Server on host computer, local or remote access
Tasks	Automate experiments, automate operation sequence for calibrations and experimental procedures, polling of parameters and signals at high rate for supervision, alarming etc.

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ISO 9001 Certificate

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