Mimea 6th Generation

THE NEW MEASUREMENT AND CONTROL SYSTEM

KEY FEATURES

- Advanced high-speed data processing architecture
- A new standard in signal quality for data acquisition and signal generation
- Unparalleled flexibility in signal modulation and mixing
- Optimal I/O placement capability via galvanically isolated optical interconnects
- Ready and open for AI integration

Nanonis™

A member of SPECSGROUP

Mimea 6th Generation

A QUANTUM LEAP FOR ADVANCED EXPERIMENTS

Made for scientific excellence

The sixth-generation Nanonis Mimea SPM control system represents a new benchmark for scanning probe microscopy, built upon a legacy of over 20 years of intensive research and development and the experience gained from over 1600 systems delivered to the global research community.

For more than a decade, the fifth generation Nanonis Mimea SPM control system has been the primary choice for the world's most demanding SPM experiments, serving as the technical foundation for countless scientific breakthroughs and high-impact publications. Following our core philosophy that the measurement instruments should never be the limiting factor in a scientific experiment, the system has undergone continuous product development driven directly by the needs of the SPM community. This unique collaboration has resulted in over a hundred new features and specialized solutions, developed by an in-house software engineering team determined to provide effective solutions and new features in a short time.

However, as experimental requirements push the boundaries of physics, the hardware platform of the controller must follow suit. The sixth generation Nanonis Mimea SPM control system addresses current and future demands through a ground-up redesign. And while the external appearance might seem familiar, the completely new hardware design and software architecture are capable of delivering performance levels previously considered inconceivable. Paired with a higher degree of modularity, the new architecture lays a solid foundation for further decades of continuous development. This major investment ensures that the system is not only capable of standard SPM measurements but is also flexible enough to address emerging applications and future scientific challenges, providing greater value for money.

By combining advanced technology and community-driven development, the Nanonis Mimea SPM control system continues to be a major contributor to global scientific excellence.

Building on legacy, developing for the future

- 1600 systems installed worldwide
- 25 years of continuous research & development

Modularity and serviceability

- Compatible with existing high voltage electronics and adaptation kits
- Modular system and modular instruments: easy to upgrade and to service
- Extensive internal monitoring to ensure smooth operation

Ultrastable, ultra low-noise and fully monitored signal generation

- Voltage or current source mode
- 31-bit DAC architecture
- 6× higher maximum bandwidth
- Up to 6× lower output noise

APIs, scripting and STM simulator

- Ready for AI: platform-agnostic APIs and native Python interface

A state of the art 25 MHz AFM interface

- Arithmetic unit for full frequency flexibility
- 2× the number of modulators and demodulators
- 5× larger bandwidth
- 5× lower input noise
- Up to 30× lower output noise

State of the art data acquisition in any experimental situation

- Selectable input gain of 1, 10 or 100
- Selectable AC coupling
- Up to 20× less input noise
- Up to 8× higher input resolution
- 100× higher input impedance
- 2× higher sampling rate

Designed for high speed and big data

- 2× larger number of physical and software signals
- Up to 16 lock-in demodulators
- 6× higher data transfer rate for each instrument
- 5× higher sampling rates possible
- Up to 50 m galvanically isolated optical interconnects between instruments

RC6 Real-Time Controller

A key benefit of the Nanonis high-speed modular architecture is the direct access and visualization of all raw signals available in the system, eliminating the need for pre-processing and data-rate reduction in add-on instruments. To ensure a low-latency and reliable data transfer at a significantly higher speed than before, a revolutionary data transfer architecture had to be designed. It supports a 7× higher data transfer rate, sampling rates up to 200 MS/s, synchronous data input and output over all interfaces in the system, and plug & play operation.

Designed for distributed measurements and optimized for low HF signature and small signals, the architecture enables a placement of the signal interfaces at a significant distance from the central processing core, the RC6, using galvanically isolated optical fibers. For complex measurements, a single system can handle over 128 outputs or inputs and over 250 monitoring signals, with over 200 signals simultaneously available in the user interface. To handle this enormous amount of data, the RC6 offers increased processing power with a larger FPGA, a more powerful CPU and faster storage.

SC6 Signal Conversion

The SC6 redefines the meaning of signal interface, offering state-of-the-art performance in any experimental situation. The 24-bit 2 MS/s ADCs paired with a low-noise, low-drift input stage with variable gain and 200 kHz bandwidth, offer a 3× reduction in broadband noise and an 8× higher effective resolution compared to the previous generation, with oversampling effective down to 1 Hz. A high-impedance input buffer, true-differential inputs and flexible GND schemes ensure optimal operation with any sample and electrical configuration, while selectable AC-coupling with high gain allows the detection of smallest modulations.

The 31-bit DAC architecture delivers incredibly clean signals down to smallest amplitudes eliminating the need for external adders. Variable filters offer a 6× higher bandwidth and an optimized impulse response for stable feedback. Output noise is twice as low, or even 6× lower in the ±2.5 V output range, with the improvement carrying over to frequencies below 0.1 Hz. Output current and voltage are constantly monitored, and all outputs can act as regulated current sources with maximum currents up to 25 mA.

OC6 Oscillation Controller

The OC6 is a state-of-the-art signal generator with 5× the bandwidth compared to the OC4, capable of generating small amplitude signals up to 100 MHz. The redesigned output signal path offers improved linearity, signal purity, and fully digital amplitude control. With user-selectable ranges and filters to reduce broadband noise and optimize signal quality for the application, it offers uncompromised performance also for signals down to DC. The high-current output stage can be bypassed for applications not requiring large driving currents, lowering noise to less than 5 nV/sqrt(Hz).

The OC6 is also a sophisticated digitizer, with a DC-coupled high-impedance, fully differential input stage, able to handle signals from DC to 25 MHz or even 100 MHz with highest accuracy. Great care has been taken to avoid any interference with even the smallest input signals, resulting in 5× less noise than the predecessor, a significantly lower 1/f corner frequency and lower distortion. The OC6 provides researchers with a unique, all-in-one tool designed to meet the most demanding requirements in AFM measurements, but able to go significantly beyond those.

Software and add-on modules

The Nanonis V6 software is both familiar and significantly more powerful. It builds on the proven and reliable V5e software, but supports all the new hardware functionality, including the extensive monitoring and safety features and the over 200 signals accessible in real-time. It offers an unparalleled flexibility in signal modulation and mixing, and twice the number of frequency generators and demodulators.

It integrates specialized tools derived from the Nanonis Tramea quantum transport measurement platform. Together with embedded control of external instruments like magnet and temperature controllers or RF generators, such modules make combined SPM and transport measurements much more manageable.

The Programming Interface, a game-changing tool for researchers for over two decades, now runs on a generic framework with dedicated Python and LabVIEW interfaces for immediate productivity, and is ready for any advances in machine-learning based routines. The V6 software combines reliability with modular features and continuous development.

Technical Data

RC6 Real-Time Controller	
Computing	6-core CPU, 8 GB RAM, 512 GB SSD, FPGA-card
Operating system	Linux RT
FPGA card	PXIe, high-speed serial interface
Connectivity	4× SC6 max., 2× OC6 dual max.

SC6 Signal Conversion	
Power supply	Powered from RC6
Electrical GND	Floating up to 30 V or PE, remote controlled, ground loop detection

Input	
Hardware interface	8× BNC connectors, differential over 2 connectors, pseudodifferential, single-ended Shield on PE, GND or floating, user-configurable
Differential input range	±10 V, ±1 V, ±100 mV (gain 1, 10, 100)
Input impedance	100 MΩ, > 1 GΩ, user configurable
Input capacitance	<40 pF
Input bias current	1.5 pA typ., 2 pA max.
Coupling	DC or AC, user-configurable
Analog bandwidth	DC-200 kHz (-3 dB) 6th order Bessel low-pass filter
AD-converter	24-bit 2 MS/s
Effective resolution	>25 bit with >4000× oversampling
INL / DNL	±2 LSB / ±0.5 LSB typical
Input noise density at gain 100	<7 nV/√Hz >100 Hz <20 nV/√Hz @1 Hz
Measurement noise at gain 100	<5 µVrms @ 2 MS/s <0.5 µVrms @ 15 kS/s <80 nVrms @ 120 S/s
0.1–10 Hz noise at gain 100	<60 nVrms
SFDR, 50 % amplitude signal, 1 kHz	>125 dB @ gain 1 >105 dB @ gain 10 >105 dB @ gain 100

Output	
Hardware interface	8× BNC connectors
Output voltage ranges	±10 V, ±2.5 V
Output current ranges	±25 mA, ±12.5 µA
Output impedance	<1 Ω (25 mA), 1 kΩ (12.5 µA)

Output	
Analog bandwidth	DC-250 kHz (-3 dB), user-configurable 100 kHz, 20 kHz, 350 Hz low-pass filters
DA converter	31-bit DAC architecture with active glitch compensation, 1 MS/s
Effective resolution	23-bit typ., >24-bit with 350 Hz filter at full sampling rate
INL / DNL	<±2 ppm max. / <±1 ppm max.
Output noise density ±10 V range	<11 nV/√Hz > 1 kHz <25 nV/√Hz @ 1 Hz
Output noise density ±2.5 V range	<3.5 nV/√Hz > 1 kHz <10 nV/√Hz @ 1 Hz
Output noise 10 – 300 kHz ±10 V range (250 kHz / 100 kHz / 20 kHz / 350 Hz filter)	<6 µVrms / <4.5 µVrms / <2.5 µVrms / <0.3 µVrms
Output noise 0.1 Hz – 10 Hz ±10 V range	<180 nVrms
Output noise 0.1 Hz – 10 Hz ±2.5 V range < 50 nVrms	<50 nVrms
12h-Drift	<25 µV p-p (@ 9.9V)

OC6 Oscillation Controller	
Power supply	Powered from RC6
Electrical GND	Floating up to 30 V or PE, remote controlled, ground loop detection

Input	
Hardware interface	2× BNC connectors, differential or single-ended
Differential input range	±10 V, ±3.3 V, ..., ± 1 mV (gain 0.1, 0.3, ..., 1000)
Input impedance	50 Ω, 100 MΩ, > 1 GΩ, DC-coupling 50 Ω, 10 MΩ, AC-coupling user configurable
Input capacitance (single-ended)	15 pF (low-capacitance mode) 40 pF (low-noise mode)
Input bias current (single-ended, input A, 60 °C)	<35 pA typ. (low-capacitance mode) <140 pA typ. (low-noise mode)
Coupling	DC or AC, user-configurable
Analog bandwidth	DC-25 MHz, -5 MHz, -500 kHz (-3 dB), 3rd order Bessel low-pass filters, user selectable
AD-converter	16-bit 200 MS/s
Effective resolution	>17 bit with >256× oversampling, 1–10 V range

Input

INL / DNL	±1.6 LSB / ±0.4 LSB typical
Input noise density in 10 mV range or lower, low-noise, single-ended	<3.5 nV/√Hz > 100 kHz <15 nV/√Hz @ 100 Hz
Measurement noise up to 500 kHz, low-noise, single-ended, 128× oversampling	<22 μVrms, 1 V range <2.5 μVrms, 10 mV range or lower
Measurement noise up to 100 MHz, low-noise, single-ended, no oversampling	<170 μVrms, 1 V range <28 μVrms, 10 mV range or lower
SFDR, 50 % amplitude signal, 1 kHz	>70 dB, 10 V range >90 dB, 1 V range

Output

Hardware interface	1 × BNC connector
Output voltage ranges	±10 V, ±1 V, ±100 mV, ±10 mV
Output current	±200 mA max. (high current) ±100 mA max. (low noise)
Output impedance	50 Ω
Analog bandwidth	DC-25 MHz, -5 MHz, -500 kHz (-3 dB), 3rd order Bessel low-pass filters, user selectable
DA converter	16-bit DAC, 200 MS/s
INL / DNL	<±1 LSB / ±0.5 LSB typical
Output noise density ±10 V range, high current	<60 nV/√Hz >10 kHz <800 nV/√Hz @ 10 Hz
Output noise density ±1 V range, high current	<25 nV/√Hz >10 kHz <250 nV/√Hz @ 10 Hz
Output noise density ±1 V range, low noise	<7 nV/√Hz >10 kHz <70 nV/√Hz @ 10 Hz
Output noise density ±10 mV range, low noise	<5 nV/√Hz >10 kHz <25 nV/√Hz @ 10 Hz
Output noise up to 500 kHz, low-noise (high-current)	<55 μVrms (<65 μVrms), ±10 V range <6 μVrms (<15 μVrms), ±1 V range <3.5 μVrms (<14 μVrms), ±10 mV range
Output noise up to 100 MHz, low-noise (high-current)	<55 μVrms (<240 μVrms), ±10 V range <55 μVrms (<65 μVrms), ±1 V range <55 μVrms (<62 μVrms), ±10 mV range
Output noise 0.1 Hz – 10 Hz, low-noise (high current)	<5 μVrms (<6.5 μVrms), ±10 V range <0.6 μVrms (<1.8 μVrms), ±1 V range <0.2 μVrms (<1.5 μVrms), ±10 mV range

Digital lines

Ports	2 × 8 bidirectional lines on two D-sub 9 female connectors for each signal interface
Signal	3.3 V TTL, max. 25 mA per line
Maximum sampling frequency	250 kHz – 1 MHz depending on configuration

High speed digital lines

Ports	2× inputs and 2× outputs on SMB male connectors for each signal interface
Signal	3.3 V TTL, max. 24 mA per line
Maximum sampling frequency	200 MHz

Clock

Ports	1× input, 1× output for active clock source
Frequency	10 MHz, 100 MHz input, 10 MHz, 100 MHz, 1 GHz output square wave, 3.3 V
Frequency calibration	±25 ppm (standard VCXO) ±1 ppm (optional OCXO)
Frequency stability vs. temperature	±15 ppm (standard VCXO) ±20 ppb (optional OCXO)

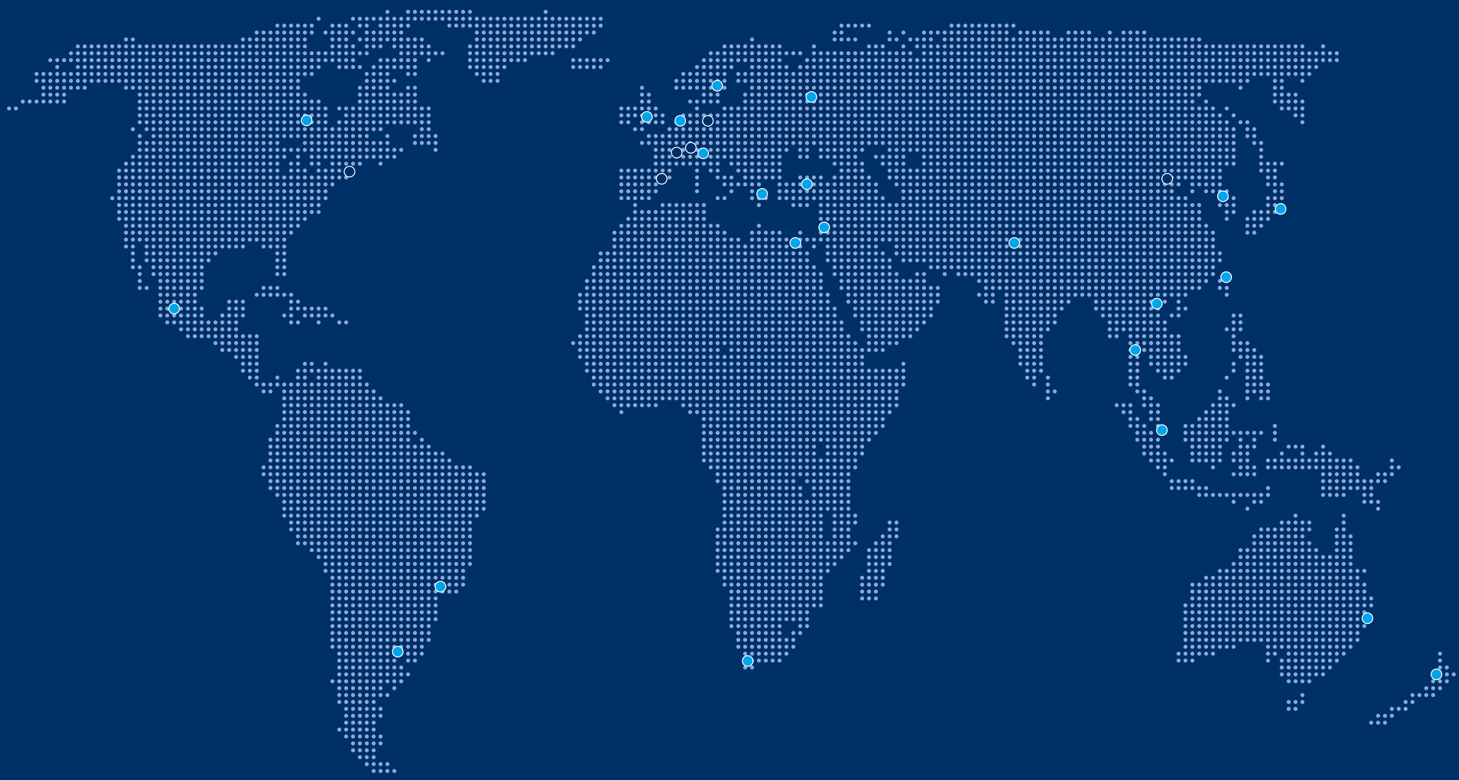
Graphical user interface

Operating system	Windows 11 64-bit

Signals

Signals	128 physical signals (inputs, outputs at 1 MS/s) 8 inputs and 8 outputs at 200 MS/s 200 internal signals 24 simultaneous signals for data acquisition 8 simultaneous signals for 1 MS/s data streaming 4 simultaneous signals for 2 MS/s burst acquisition 24 simultaneous signals for real-time data logging
Data transfer	Via TCP/IP, 2 kS/s default, up to 20 kS/s, 1 MS/s × 8 channels for data streaming
Representation	32-bit floating point, real-world physical units

* Specifications are subject to change without notice.



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