# Nanonis Mimea

1029003

## Technical Specifications

| | |
|---|---|
| **Size and Dimensions** | |
| chassis | OC4 33 x 28 x 7 cm |
| | RC5e 33 x 28 x 21 cm |
| | SC5 33 x 28 x 7 cm |
| weight | SC5 4.2 kg |
| | RC5e 8 kg |
| | OC4 3.7 kg |
| **Controller Hardware** | |
| power supply | 100-240 V ±10%, 50/60 Hz ±5%, Fuses 200 V T4AH (RC5e), 100/120/230 V ±10%, 50/60 Hz ±5%, Fuses 250 V 2AT (SC5, OC4) |
| power consumption [W] | RC5e 85 W typ., 220W max. |
| | SC5 35 W typ., 60W max. |
| | OC4 11 W typ., 25W max. |
| connector | IEC inlet (3x) |
| **RC5e computing and connectivity** | |
| real-time processing | NI PXIe-8840 real-time system with Intel Corei5 CPU 2.7 GHz, 4 GB RAM |
| FPGA | NI PXIe-7976 |
| operating system | LabVIEW real-time OS |
| signal interfaces connectivity | 3x SC5 max., 2x SO5 max., 2x OC4 max. Total of max. 6 frontends |
| data transfer to host PC | 1 Gbit/s TCP/IP, 2 kS/s default, up to 20 kS/s, 1 MS/s x 8 channels for data streaming |
| **Output Signals** | |
| frequency range | DC - 40 kHz (SC5), 100 Hz - 5 MHz (OC4) |
| **Detection** | |
| measurement bandwidth | DC - 100 kHz (SC5), 100 Hz - 5 MHz (OC4) |
| **Interfaces** | |
| xy scan voltage output | (SC5) 2x BNC -10..+10 V, 20 bit (22 bit with hrDAC), 1 MS/s, 40 kHz, bipolar or unipolar, output limiter, tilt- and drift correction |
| z voltage output | (SC5) 1x -10..+10 V, 20 bit (22 bit with hrDAC), 1 MS/s, 40 kHz, bipolar or unipolar, output limiter, tilt- and drift correction |
| analog ADC inputs | (SC5) 8x BNC -10..+10 V, 18 bit, 1 MS/s, 100 kHz. Can be extended to up to 24 inputs |
| analog DAC outputs | (SC5) 8x BNC -10..+10 V, 20 bit (22 bit with hrDAC), 1 MS/s, 40 kHz (3 outputs used for xy and z). Can be extended to up to 48 outputs |
| high frequency section | (OC4) -10..+10 V, 14 bit, 40 MS/s, 5 MHz ADC and DAC. 16 bit amplitude resolution. Dual Option available. Sync output, TTL-phase-sync output |
| general purpose digital interface | 32 bidirectional 500 kHz TTL I/Os for communication and triggering. Pixel-, line-, frame sync available. 4x input and 4x output 200 MHz TTL I/Os for pulse counting and triggering |
| host computer interface | Ethernet 1 Gbit |
| auxiliary power outlet | +/-15 V (0.3 A) |
| **Resolution** | |
| frame view display modes | up to 7 frame views, 2 line views, generation of additional views with programming interface |
| frame view options | various fitting-, saving (.sxm), and scaling options |
| frame view selection tools | frame position, rotation, scaling, centering, zoom on the fly. Dedicated grid, subgrid and point modes |
| **Scan Generation** | |
| pixel clock [kHz] | 20 kHz for normal scan engine, 1 MHz for fast scan engine |
| resolution | up to 22 bits, depending on oversampling |
| features (scan) | global and local slope compensation |
| scan speed | 100 pm/s - 1.2 mm/s @ 30µm x 30µm (slow scan engine); 30 µm/s - 30 cm/s @ 30µm x 30µm (fast scan engine) |
| frame rate | max. 0.9 Hz @ 100 x 100 pixel (slow scan engine); 50 Hz @ 100 x 100 pixel (fast scan engine) |
| **Signal Architecture** | |
| number of internal signals | 128, access from all software modules and from multiple software modules |
| data rate | 20 KS/s, 1 MS/s, maximum oversampling automatically applied for a given data acquisition rate |
| max. simultaneously acquired signals at 20 kS/s | 24 + 24 for data logging |
| max. simultaneously acquired signals at 1 MS/s | 8 |
| experiments | multiple experiments can be performed in parallel without performance degradation |
| real-time operations | mathematical operations between signals are possible in real-time |
| units | real-world, calibrated SI-units throughout the software |
| data logging | continuous data logging with up to 100 M points per file and up to 24 channels at up to 20 kS/s |
| data display | multiple charts, graphs, oscilloscopes and spectrum analyzer |
| **Sample Positioning** | |
| sensor type | interferometric (IDS) or position triggered scanning |
| closed loop sensor range | 5 mm x 5 mm |
| closed loop scan resolution (steady state, 100 ms sample time) | down to 1 nm (usually limited by noise & vibration levels) |

| | |
|---|---|
| **Z Controller** | |
| operation | on the fly switching between controller modes and signals |
| z feedback | digital P/I, anti wind-up |
| z resolution | 18 bit, internal resolution of 32 bit |
| input control signal | any input or internal signal channel |
| features (z controller) | linear, absolute and logarithmic controllers, control on multiple signals (sum, subtraction multiplication, division), invertible polarity, P/I gain in physical units |
| safety | SafeTip functionality for tipcrash protection, triggered by any internal signal. Autorecovery options and autowithfraw including coase motion withdraw for minimzation of data losses and tip damage |
| **Oscillation control** | |
| lock-in signal processing | configurable filters, cut-off frequency between 1 mHz and 50 kHz (time constant), slope between 1. and 8. order |
| demodulators | four independent demodulators for multi-harmonics measurements |
| PLL parameter tuning | PerfectPLL for for automating tuning of PLL parameters according to oscillator parameters |
| resonance curve | frequency sweep with autofit-routine for phase slope, amplitude or phase curve, improves fit precision from UHV to liquid environment |
| Q-control | Q-factor reduction (to 0) or enhancement |
| signal analysis | 40 MS/s oscilloscope and FFT with up to 32k samples, Zoom FFT with filter compensation |
| **Phase Locked Loop (PLL)** | |
| features (PLL) | 2 P/I controllers (4 with dual-OC4) with graphical interface |
| frequency resolution [µHz] | < 1 nHz |
| dual PLL | dual PLL option for multi-excitation schemes. Inlcudes TrueDissipation algorithm and calibration for enhanced dissipation measurements |
| **Q Control** | |
| q feedback type | digital, phase controlled |
| efficiency of Q control | decrease or increase of Q by up to 100% |
| **Spectral Performance** | |
| spectroscopy modes | point/line/grid/subgrid/follow-me spectroscopy (up to 8192 x 8192 pixel for grid and subgrid) |
| spectroscopy type | z-spectroscopy, bias spectroscopy, generic spectroscopy (all GUI parameters), dI/dV with internal Lock-In |
| averaging | 1 us up to 10 s per data point |
| experiments | bias spectroscopy, Z-spectroscopy, generic spectroscopy including time spectroscopy. All modes can be combined with lock-in measurements. |
| data acquisition speed | up to 20 kS/s for bias and Z-spectroscopy, up to 1 MS/s for high-speed generic spectroscopy |
| timing control | start and end settling times, settling time per point, integration time per point. All timing is deterministic. Variable spectroscopy resolution/timing possible |
| autoretract | arbitrary threshold condition, including dual-condition autoretract |
| data display | real-time display for measurements > 2s |
| custom spectroscopy | possible with programming interface or scripting |
| **Second Pass Mode** | |
| second pass mode - working principle | multipass with up to 512 passes with different parameter set |
| second pass mode - parameters | playback recorded pass with parameter offset, wait time, slew rate, speed ratio, alternate setpoint, lock-in on/off |
| application for second pass mode | e.g. MFM, SGM, EFM, KPFM |
| **Lock-In** | |
| number of lock-ins | 1 dual-phase lock-in, up to 8 dual-phase lock-ins possible |
| low frequency Lock-In | 10 mHz - 50 kHz modulation frequency, 120 dB dynamic range, > 100 dB effective dynamic reserve, THD+N better than 90 dB |
| modulation | all DAC channel and most internal signals |
| high frequency Lock-In | 100 Hz - 5 MHz |
| integration time | sync filter and/or low-pass filters (1. to 8. order), cut-off frequency of 75 uHz to 20 kHz (low-frequency Lock-in), 95 mHz to 50 kHz (high-speed Lock-in) |
| lock-in usage | AFM cantilever signal, tuning fork signal etc. (high frequency Lock-In), spectroscopy, vibrational analysis, electrical transport, magnetotransport (low frequency Lock-In) |
| **Optical Data** | |
| oscilloscope | single and dual channel oscilloscopes, arbitrary channels, time base 128 ms to 6.4 s, 2 kHz range, 8192 pixel. Optional 4-channel oscilloscope and spectrum analyzer (time base 32 us to 17 minutes, 1M |
| FFTs | spectrum analyzer, 0-1 kHz range, windowing options, variable averaging. Optional 500 kHz spectrum analyzer |
| **Options and Upgrades** | |
| features (transfer function) | various current preamplifiers, up to 2 MCVA5 differntial voltage preamplifiers. I/O extension to up to 24 inputs and 40 outputs or 16 inputs and 48 outputs. Dual-PLL. RF source up to 40 GHz |
| features (crosslink) | up to 8 lock-ins, up to 8 generic P/I loops, KPFM-Module, Atom-tracking module, real-time scripting module, 4-channel oscilloscope module, Multi-Modulator module, Trigger engine-module |
| **Scan control** | |
| scan engines | 2 independent scan engines, one for standard measurements and spectroscopy (20 kpixel/s), one for high speed or very high resolution scanning (1 Mpixel/s) |
| scan management | on the fly scan pattern control (size, position, rotation), with independent visualization controls (zoom, position,...) All parameters can be adjusted without stopping data acquisition |
| history display | up to 50 acquired images can be pasted to scan display background, background management tool |
| tilt compensation | automatic for full scan frame or user-defined area |
| scan display | up to 7 scan displays |

| | |
|---|---|
| multipass mode | records any signal on first pass and plays it back on following passes. Multiple passes with configurable z-offset, bias, scan speed and setpoint settings, independent for forward and backward |
| point and shoot spectroscopy | any spectroscopy measurement, or any custom routine or script can be executed on the fly during scan |
| scangrid spectroscopy | combined scan and grid spectroscopy. Topographic information with scan resolution and user configura |
| spectroscopy experiments | all standard experiments, additionally any routine configured in scripting or programming interface |
| Programming interface | |
| labVIEW Programming interface | library of VIs that allows a flexible implementation of user-defined and automated measurement routines. Full control of the Nanonis SPM controller over the Programming Interface. Direct control of ex |
| generic Programming interface | same functionality as LabVIEW programming interface, compatible with any programming language (Pytho |
| python interface | python interface for the generic programming interface available on pypi.org |
| Simulation mode | |
| installation | simulation mode available with software, no limit in number of installations. Additional standalone STM simulator applciation |
| functionality | simulates a Si(111) surface, allows simulated STM measurements and access to full software fucntionality over programming interfaces |
| scope | training without hardware, testing of programming interface and scripting routines |