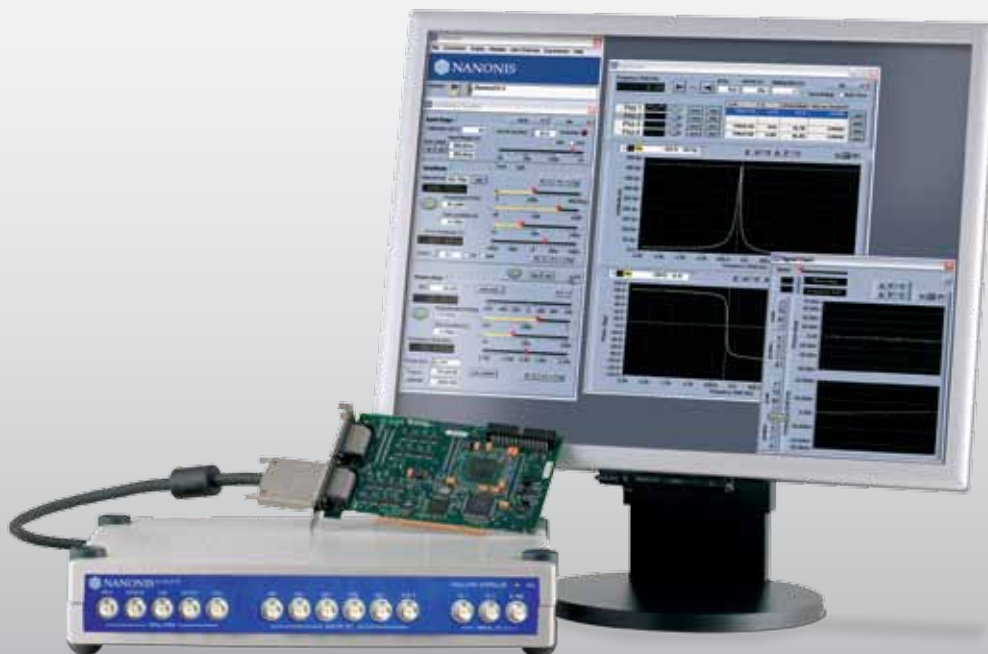


COMPONENTS FOR SURFACE ANALYSIS

OC4

Oscillation Controller

For the Finest Control of Mechanical Oscillators



Outstanding

- Functionality
- Bandwidth
- Precision
- Ease of use

Sensors

- Cantilever Sensors
- Akiyama Sensor
- Tuning Forks
- KolibriSensor[®]
- Needle Sensor
- Q-Plus Sensor

Applications

- ncAFM
- High Speed ncAFM
- KPFM
- MFM
- Multi-Resonance Modes
- MRFM
- SNOM
- MEMS / NEMS
- Piezo Response
- AFM in Liquids
- Bimodal AFM
- Multifrequency AFM
- Higher Harmonics

Functions

- PLL
- Amplitude Controller
- Kelvin Controller
- Lock-in
- Spectrum Analyzer
- Oscilloscope
- Frequency Generator

OC4 – Oscillation Controller

The physical parameter that lends itself to the most accurate measurement in nature is frequency. It therefore follows that other physical properties that can be converted to a frequency may also be measured with a high degree of precision. This can be accomplished by tracking the responses of a high quality mechanical oscillator using the OC4.

From 100 Hz to 5 MHz

With an analog bandwidth of 5 MHz the OC4 is well-suited to operating at higher resonance modes, to small cantilevers with high resonance frequency and to high-speed AFM. On the other hand, frequencies as low as 100 Hz make the OC4 ideal for AFM applications in liquids, for magnetic resonance force microscopy and for macroscopic oscillators in general.

Frequency Resolution

The frequency resolution of the OC4 is so high that in practice the digital quantization is not observable at all. The direct digital synthesis (DDS) has a phase accumulation register of 64-bit, which results in a nominal frequency resolution far below 1 nHz.

Frequency Stability

With stability of 1 ppb (per day, 0.05 ppb for one second), ultraprecise generation and measurement of frequencies have been made possible. This is of utmost importance in applications with small relative frequency shifts, such as MRFM and MFM, and with certain instruments including tuning forks and cantilever balances.

Low Noise Input

The input of the OC4 is optimized to digitize the signal with the lowest noise and the highest resolution. A differential input buffer, variable gain preamplifier, signal filters and a 14-bit DAC @ 40 MS/s form a state of the art input stage for the applications of the OC4.

The noise of the input signal is usually the factor that limits frequency resolution in a PLL application. Compared with the signal noise, the input noise of the OC4 is so low that it is insignificant. The only remaining limits are therefore the detector noise or the thermal noise from the mechanical resonator.

Oscilloscope and a Spectrum Analyzer

As the OC4 can digitize signals up to 5 MHz without loss of signal quality, it performs the same functions as a high performance oscilloscope and a spectrum analyzer. The specifications of the OC4 are impressive and the software provides the same features as the latest models of such instruments, but at a much lower cost.

The built-in demodulator even makes Zoom-FFT possible, allowing quantitative thermal noise analysis and calibration of spring constant or amplitude.

Demodulation Bandwidth

The amplitude and phase controller can be trimmed to control bandwidths of up to 5 kHz. This results in faster applications. Furthermore, the demodulation bandwidth can be reduced significantly below 1 Hz, allowing ultra-low noise and small signal measurements.

High Resolution of Internal Signals

The usual limitation in range and resolution of digital signals is overcome by using high bit depth to represent the internal digital signals. The filters and PI controllers are implemented with 64-bit calculations. Internal signals are represented at 32 bits with at least 1 MS/s.

Wide Range of Signal Levels

To cope with the large variations of excitation and oscillation amplitudes the input and output of the OC4 allow adjustment of the gain over a wide range.

Both input and output have electronic signal amplitudes of up to ± 10 V and down to sub-mV. The switching of dividers and adjusting of gains is managed via the software and the signal calibration is maintained.

System Integration

The OC4 is available as a stand-alone version and as an add-on to the Nanonis SPM Control System. Up to six analog outputs and two digital lines allow easy integration with any SPM controller.

Digital integration with the Nanonis SPM controller brings additional advantages including the integrated user interface, direct digital signal communication without limitation in range and resolution, as well as reduced latency.

Kelvin Controller and z-Controller

Two auxiliary outputs can be used to control the bias voltage and the z-signal for tip-sample distance control. Two generic PI controllers allow for various Kelvin Probe techniques and z-controller modes. Powerful and easy to use software supports these advanced SPM applications.

SafeTip™

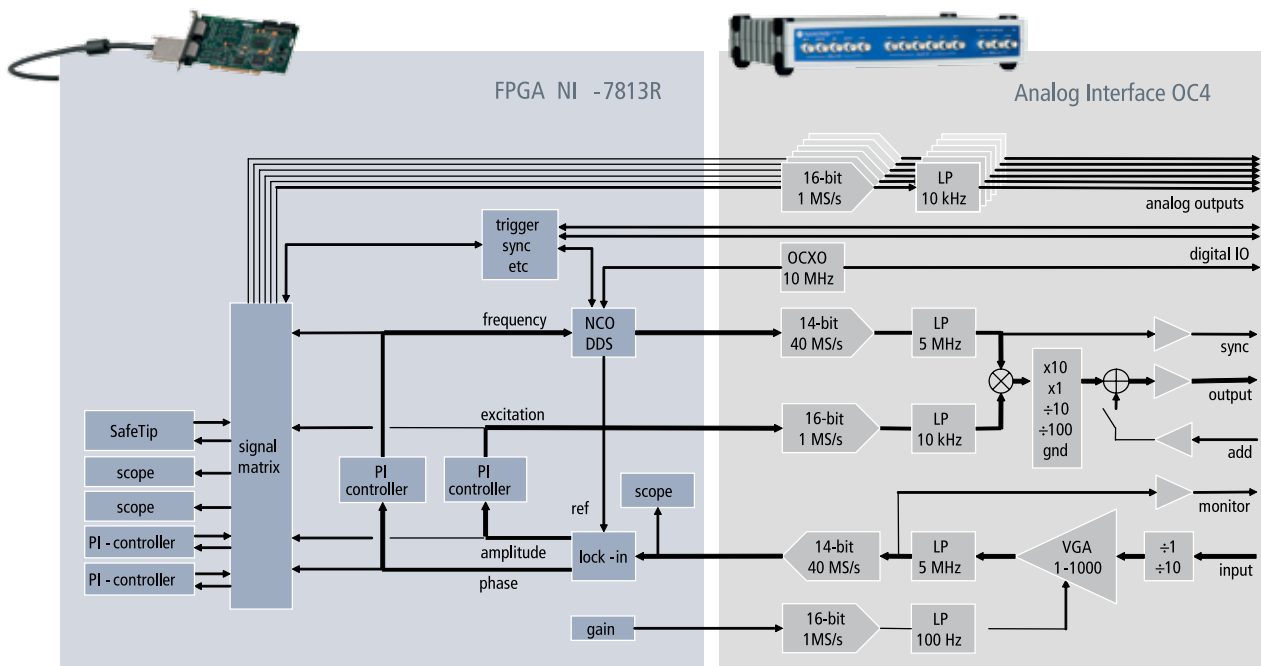
The SafeTip™ feature, which prevents tip crashes, is especially useful for ncAFM. The benefits of SafeTip™ include longer tip life and less time spent on replacing tips. In addition, experimental freedom is enhanced by having reduced the risk of tip crashes and the associated repair time.

Software

Many specialized software tools, which have been developed by SPM application experts, are designed to help with everyday work. With a few mouse clicks one can find the resonance, determine the Q-factor, set up the perfectPLL™ parameters, compensate the contact potential, and more. Complex made easy: with an overview of up to four nested PI controllers running in parallel. The LabVIEW programming interface together with the option to have customized functionality programmed onto the FPGA makes the OC4 an extremely flexible device.

perfectPLL™

With perfectPLL™, easy and perfect operation of the PLL is guaranteed. The perfect PI parameters are computed and configured for any Q-factor and desired detection bandwidth. Feedback is stable and ringing is avoided. The only parameter adjustment required is the compromise between speed and low-noise.



Specifications

Functions	
Lock-in	True phase and amplitude and x, y measurements frequency response measurements, Bode- & Nyquist plots phase sweeps, higher harmonics
PLL	Constant phase, with const. excitation or const. amplitude auto PLL setup with perfectPLL™
Kelvin Probe	Frequency modulation & amplitude modulation technique
Oscilloscope	3 channels, triggering, 100 kS/s per channel cont. acquisition
ZoomFFT	High resolution spectrum around a center frequency, noise analysis, estimation of spring const. or sig. calibration
General	
Dimensions	32.5 x 28 x 7 cm
Weight	3.6 kg
Mounting	Stackable benchtop casing, rack mount kit available
Power supply	10 W, 100 V - 240 V, 50 - 60 Hz, automatic switching, toroidal transformer, linear regulated
Operating temperature	+5° C to +40° C
Compliance	CE
Warranty	1 year parts and labor on defects in material and workmanship
Operating system	Windows XP, Vista
Computer Connection	
Interface card	PCI plug in card: Nat. Inst. FPGA card NI-PCI-7813R
Grounds	Chassis ground and DGND of computer separated
Auxiliary DC Power Outlet	
Connector	4-pin lemo on rear panel
Power	±15 V, 100 mA max.
Protection	Undervoltage detection with LED indication
Ground	Floating, 100 kΩ to AGND
Analog Outputs	
Signals	AMP, PHA, EXC, FRQ, AUX1, AUX2
Converter	16-bit, 1 MS/s, ±10 V
Analog bandwidth	10 kHz, 4th order low pass filter
Digital Lines	
Channels	2 on BNC, input or output jumper configurable
Output impedance	50 Ω

Signal Input	
Analog bandwidth	100 Hz - 5 MHz
A/D conversion	14-bit @ 40 MS/s
Input voltage noise	15 nV / sqrt(Hz)
Grounding	BNC shield to AGND or floating via 10 kΩ (differential)
Diff. input impedance	20 kΩ / 10 pF
CMRR	110 dB @ 1 kHz, 95 dB @ 1 MHz
Max. safe input	±15 V
Preamplifier	Divider ÷1, ÷10, VGA gain 1 - 1000
Full scale input	±1 mV to ±10 V, continuous, log scale
Monitor output	Monitor of signal going to ADC, ±1 V full range
Oscillator	
Min. setting resolution	4.3 pHz
Stability	0.05 ppb / s, 1 ppb / day, 4 ppm / 10 years
Sine output (sync)	±1 V sine
Excitation Output	
Bandwidth	100 Hz - 5 MHz
Amplitude modulation	16-bit, 10 kHz, ±range
Range	±10 V, ±1 V, ±100 mV, ±10 mV
Signal adder	DC and AC, up to 5 MHz, ±10 V max
Reference Signal	
Phase set resolution	24-bit
Harmonic detection	1 - 32
Demodulator	
Time constant	1 μs - 10 s
Slope	24 dB / oct
Output signals	x, y, amp, pha, 32-bit on full range
Oscilloscope	
Channels (simultaneous)	2 channels up to 1 MS/s with 32-bit per sample (internal sig.) 1 channel up to 40 MS/s with 16-bit per sample (sig. input)
Trigger modes	Continuous, internal, manual trigger, manual arming
pre- / post trigger	0 - 1024 S pre trigger, 0 - 32 kS post trigger
PI Controllers	
Number of controllers	4
Implementation	Anti-windup & bump-less, 24-bit floating point PI parameters
Closed loop bandwidth	1 mHz to 5 kHz

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