

alphaControl

Digital Controller for Scanning Probe Microscopy

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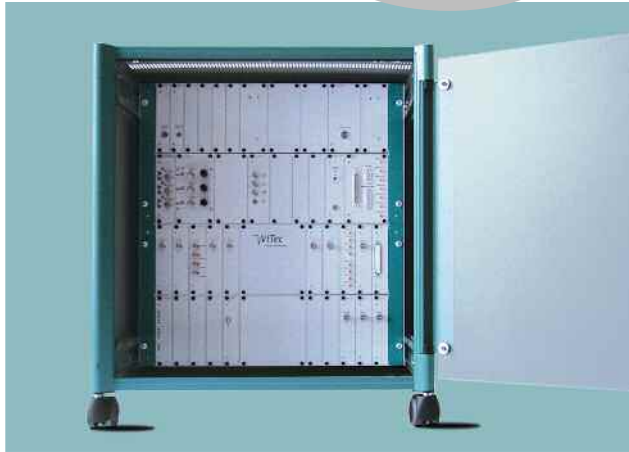


alphaControl

Digital Controller for Scanning Probe Microscopy

The alphaControl is a digital microscope controller with a radical new concept: System-on-a-Chip. The digital component of the system is entirely realized within one Field Programmable Gate Array (FPGA). This results in speed, flexibility, accuracy, expandability and precise timing.

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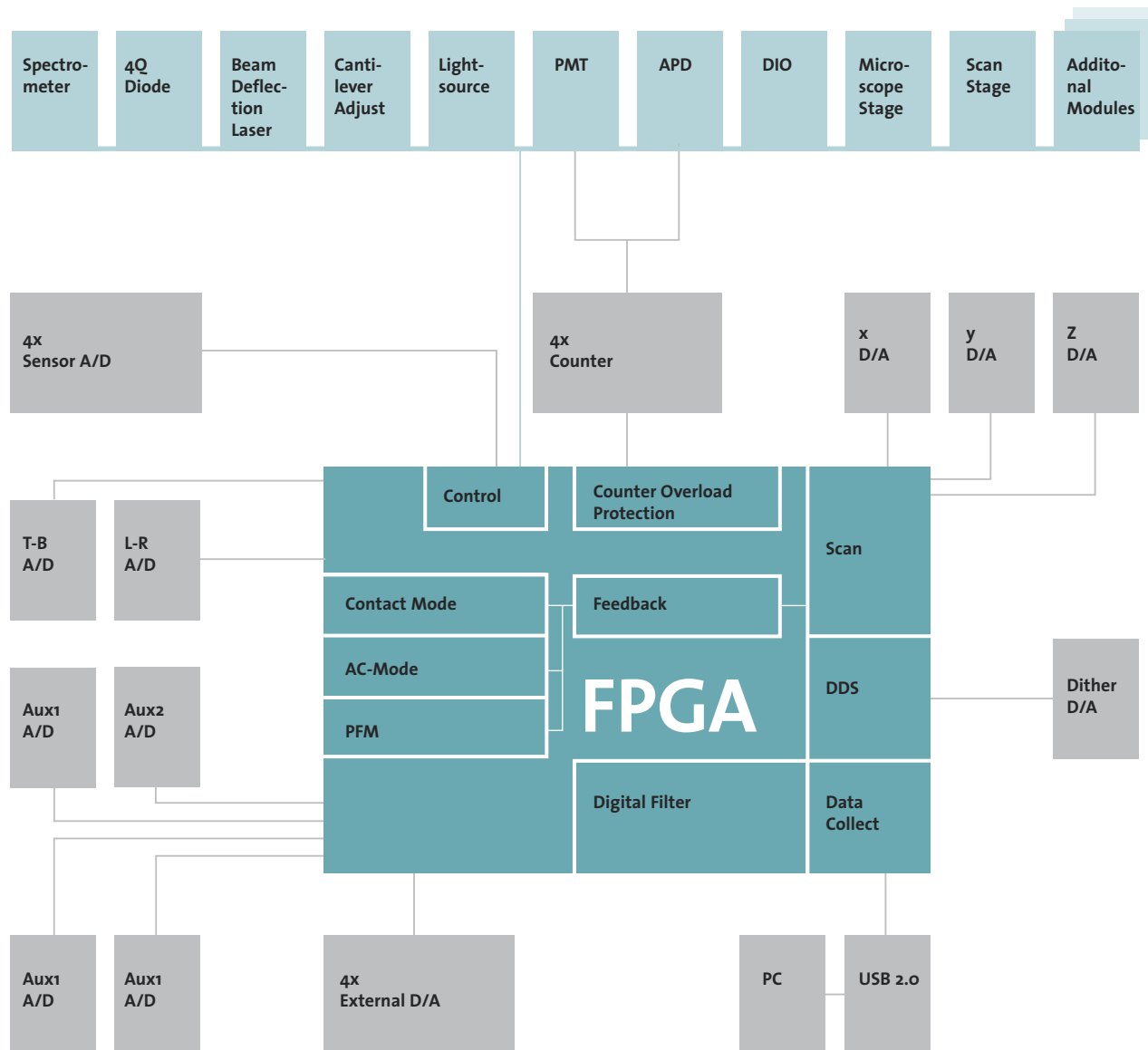
System Architecture

High resolution scanning probe and optical microscopy requires multiple tasks such as scanning, feedback control, data acquisition, communication with the host computer, etc., to be performed simultaneously. To overcome the disadvantages of DSP/CPU-based systems, which can carry out multiple tasks only sequentially, the patent-pending alphaControl FPGA-based architecture has been developed. It uses a star topology, which allows true parallel execution of multiple tasks without conflicts, bottlenecks or decreases in performance, guaranteeing the autonomy of all modules as well as real-time data processing. This enables higher data throughput and lets the four simultaneously served 16bit, 5 MHz A/D converters provide unrivaled speed and

stability. The separation of analog and digital circuitry reduces noise to extremely low levels and significantly enhances data and image quality. New functionality can be implemented at any time by simply reprogramming the FPGA. This flexibility – a cornerstone of the WITec product philosophy – is also reflected in the modular design of the alphaControl, consisting of a main rack housing the FPGA and its attached devices, and an Extension Rack for power supplies along with microscope and motor control units.

Main Rack

The FPGA-based system architecture includes more than 600 I/O lines. Multiple subsystems such as A/D and D/A converters, the USB 2.0 interface, counters and digital I/O lines are connected directly to the FPGA.



This allows advanced SPM measurements to be performed with D/A driving frequencies of 1.25 MHz and A/D sampling rates of 5 MHz (16 bit) for the T-B and L-R signals of the segmented photodiode, as well as for two auxiliary inputs, resulting in 40 MBytes/s of data input. The highly parallel data processing handles these data rates in real-time. Digital filtering for optimum noise suppression and fully digital feedback control with minimum time delay is also implemented. Communication with the host PC is facilitated through a high-speed USB 2.0 (480 MBit/s) connection, allowing continuous data streams of 20 MByte/s to and 10 MByte/s from the host computer. A fully digital lock-in amplifier for AC-mode operation up to 1 MHz, as well as the *Pulsed Force Mode* (optional) are integrated within

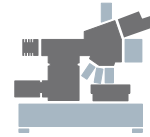
the programmed logic, providing advanced imaging modes with the highest accuracy. Various extension ports and several auxiliary A/D and D/A converters provide customers with creative flexibility.

Extension Rack

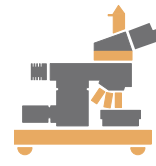
The microscope control units, power supplies and motor control units are housed within the Extension Rack, as are additional slots for further expansion.



alpha300 S SNOM



alpha300 A AFM



alpha300 R Raman

The digital alphaControl connects to all WITec microscopy systems, furthering WITec's philosophy of a modular and upgradable product platform.



alphaControl

Extension Rack

Technical Data

Main Rack

- 3x triple 16 bit D/A 50 MHz (offset, range 400 kHz, scan 1.25 MHz driving freq.) for XYZ scanning
- 2x 16 bit 5 MHz A/D, 5 MHz driving freq. for segmented photodiode (T-B, L-R)
- 2x 16 bit 50 MHz D/A, 1.25MHz driving freq. AUXOUT₁ AUXOUT₂
- 1x 16 bit 50 MHz D/A, 20 MHz driving freq. DITHER for dynamic AFM modes
- 2x A/D 16 bit 5 MHz driving freq. (Auxiliary A/D)
- 4x A/D 16 bit 200 kHz (Sum Signal, Sensor Signals)
- 4x D/A 16 bit 200 kHz optional
- 4x 32 bit Counter with overload protection
- 4x digital input for user applications or extensions
- 7x digital output for user applications or extensions
- 3x RS232 for user applications or extensions
- 2 free slots for future extensions
- USB 2.0 connection (high speed, 480 MBit) to computer
- 32 MByte SDRAM
- 2 MByte SRAM
- FPGA 80 MHz
- Built-in digital feedback controller
- 16 Built-in digital filters
- Built-in fast data streaming capabilities up to 20 MByte per second
- Built-in digital lock-in amplifier up to 1 MHz
- Built-in Pulsed Force Mode (optional)
- Galvanic insulation of analog electronics
- Scan engine with simultaneous scanning of up to 4 axes
- Extremely low noise

Extension Rack

- XYZ scanner with closed loop controlled piezos and capacitive position measurement
- Beam deflection laser with single mode fiber coupling
- 3x digital input
- 1x digital output
- Inertial drive for xyz positioning of the cantilever
- White light LED for Köhler illumination
- Microscope z-axis control
- Heating stage with temperature controller (optional)
- Control for UHTS spectrometer (optional)
- 3 free slots for further extensions

Main Rack

Features & Software



A new software concept enables unique features to be accessed for intelligent and flexible measurement control.



User Benefits

- TrueScan™
- Auto high speed cantilever approach
- High speed frequency scan
- Auto adjust cantilever focus
- Auto adjust cantilever position
- Auto adjust light intensity
- High speed overload protection for photon counting detectors
- Built-in fully digital lock-in amplifier (real amplitude and real phase up to 1 MHz)
- Fully digital feedback control
- High speed USB 2.0 interface (continuous data stream of 20 MByte/s to and 10 MByte/s from host computer)
- Effective 19bit scan DACs
- Real-time rotation matrix and real-time translation for XYZ scans
- Precise timing
- Complete access to internal signals
- Expandable

WITec Control Software

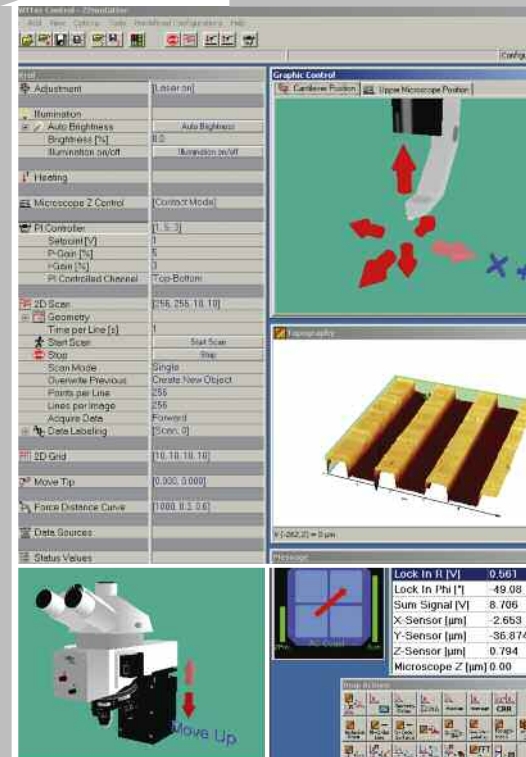
The WITec Control software is optimized for use with the alphaControl hardware. The modular design of the controller is reflected in the software. The intuitive user interface changes automatically depending on the experiment and includes specialized routines and step-by-step sequences.

Control Window

The new concept of a Control Window enables fast access to a variety of parameters without resulting in the clutter of multiple windows. It lists all available parameters and gives detailed access to measurement tasks, settings and signals. The tree structure makes locating parameters fast and easy. Information concerning important system parameters are additionally displayed in graphical status windows.

TrueScan™

TrueScan™ is an integrated scan engine including dynamic position error correction, continuous scanning without time gaps and script-based nanolithography. While a closed-loop scan system eliminates static position errors, TrueScan™ additionally incorporates dynamic position error correction capabilities. Extremely precise synchronization of scan motion with internal and external measurement tasks is achieved by triggers with sub-pixel time resolution.



The Control Window navigates the user through the measurement tasks intuitively.

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