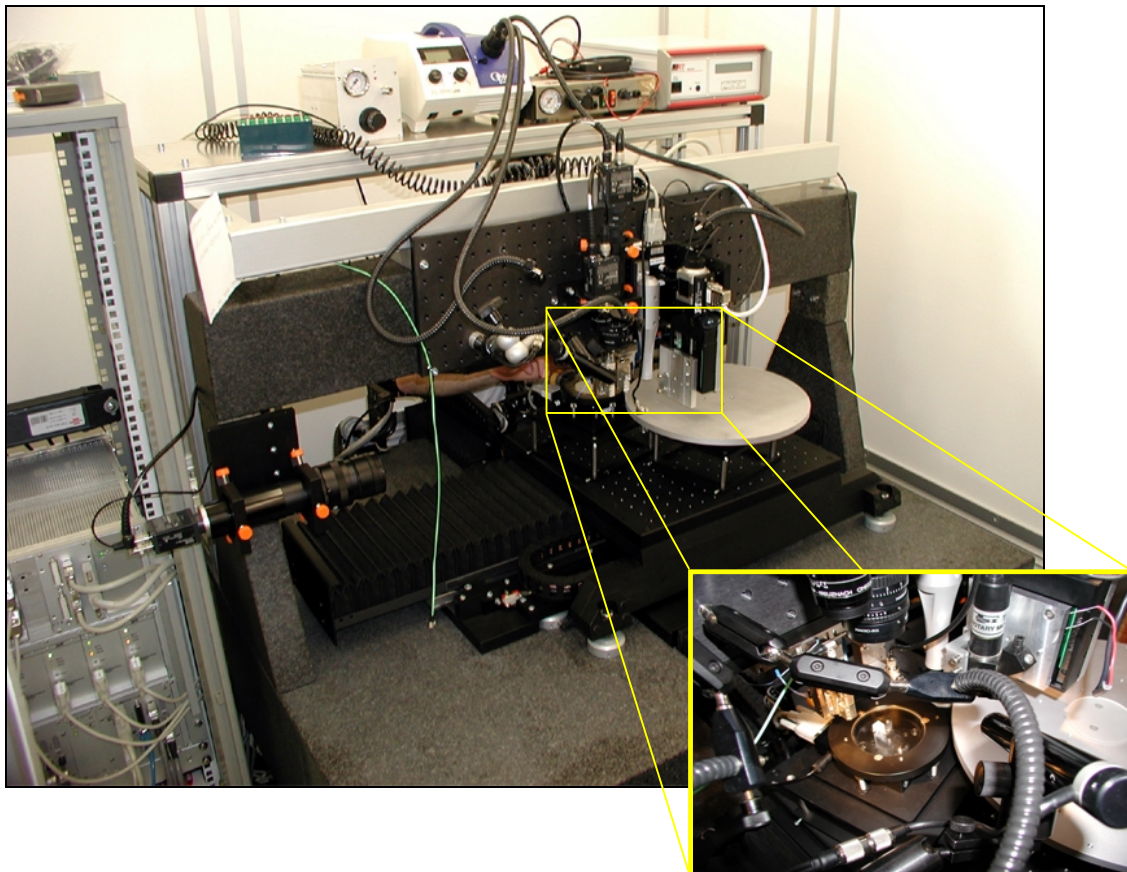


### Micro Production System with Nano-Resolution for automatic Microassembly and Interconnection Technology

This document describes the components of our Micro Production System including e.g. Nanorobotics, gripper systems, micro adhesive bonding tools, Wafer Probers, sensors and quality control modules, vision system and process control. The Nanorobotics stages („NMT xx“) operate with a resolution better 5 Nanometer at strokes up to 50 mm. The repeatability of these stages equipped with internal position sensors is better 60 nm in each axis. The grippers of our Nanorobotics series („NMG“) move with atomic resolution to handle smallest particles extremely sensitively. This Nanorobotics series is the basis of an ultra-precise handling stage. In particular with respect to the rapid miniaturization of products to assemble, the excellent precision of such a system guarantees a long time usage. In comparison with classical assembly lines (e.g. to produce mobile phones with 20-50  $\mu\text{m}$  precision) our Micro Production Systems offer up to a factor of 100 more precision. The combination of Nanorobotics with an XY-stage that moves with 350 x 350 mm<sup>2</sup> stroke at 160 nm resolution (internal interpolation) and two rotary drives allows to handle objects on more than 1000 cm<sup>2</sup> with up to a few single Nanometer resolution. Such a system is used by experts in micro adhesive bonding technology. The complete system was designed for this application, because micro adhesive bonding is the core technology for microassembly. This group of experts operates in close co-operation with us and offers their knowledge as service for the development of an assembly process.

In addition we developed together with partners the nanomanipulation and handling of particles that are too small to be gripped with standard grippers. This handling techniques can also be used with the manipulators of the Micro Production System.

An automatic process can be realized either by the position sensors of all axes or by the vision system. The process control is made by a series of external PC-Servers and Ethernet-communication. The software allows to generate own programs easily with a graphical user interface, programming knowledge is not necessary. The complete Micro Production System can be realized in steps of functional groups like a construction kit. The components of these groups will be described on the next pages. These groups can be combined in many ways to realize different applications.



Pos	Sub-systems with their individual components:
	<p><b>1. Nanorobotics-stage with basic electronics, software and video microscope:</b></p> <p>1 Nanorobotics:            XY-stage, resolution better 5 nm, 50 mm stroke, including Position Measurement System (PMS)            Z-axis, resolution better 5 nm, 20 mm stroke, including PMS            Gripper: 1 Nanorobotics Planar Gripper, atomic resolution            Electronics: 4 Channel Network Controller</p> <p>2 Basic electronics equipment:            19" Subrack, power supply, 8 channel relais unit for digital out, emergency stop, cable channels and accessory</p> <p>3 Process Control: manual program and drivers:            Basic software: NanoControl            1. add-on: multi desktop unit (to save different configurations)            2. add-on: manual positioning array (for moving manually to stored positions)            3. add-on: digital &amp; analogue I/O            8 axis Joystick incl. software and activeX interface            Configuration as system and installation of initialization functions            Optional: high-end PC</p> <p>4 Video microscope and accessory:            1 Miniature BW video camera with ultra-wide range zoom, oil pressure pivot arm, power supply, cables            1 small BW inspection monitor            1 adjustable cold light source with 3 flexible optical fibers and pivot arms</p> <p>5 Portal frame structure with base plate and mechanics to fix the Nanorobotics and camera</p>
	<p><b>2. Extension with Nanorobotics modules, further sensors and actuators:</b></p> <p>6 Electronics:            4 Channel Network Controller, Ethernet Hub for the communication with the Client PC</p> <p>7 Micro adhesive dispenser:            Nanorobotics Z-axis, resolution better 5 nm, 20 mm stroke, including PMS            Dispenser electronics with precise pulse control for small glue dots or lines, compatible with the Network Controller (without air pressure support)            Dispenser-set (holder, cartridge, cannula, hoses)</p> <p>8 Vacuum gripper with different tips:            Nanorobotics Z-axis, resolution better 5 nm, 20 mm stroke, including PMS            Vacuum control electronics, compatible with the Network Controller            Gripper head, compatible with the Z-axis            Set of different vacuum tips incl. adapter at the gripper head.</p> <p>9 Nanomotor gripper set:            Nanorobotics Z-axis, resolution better 5 nm, 20 mm stroke, including PMS            7 Planar grippers, each incl. 1 small Nanomotor, 1 individual Microstructure, 1 mounting. Resolution: atomic</p> <p>10 Force Sensor:            Calibrated force sensor with electronics, mN resolution, interface to the Network Controller            Mounting with pulse wave damping, compatible to the Z-axis            Force-Feedback Joystick            Force Feedback software (including functions like „move axis until a force is reached)</p> <p>11 Nanorobotics Modules:            Second Y-axis to carry 2 Nanorobotics Z-axes, resolution better 5 nm, 50 mm stroke, including PMS and mechanics for the assembly</p> <p>12 Four point contact prober with 4 independent probe tips:            Nanorobotics Z-axis, resolution better 5 nm, 20 mm stroke, including PMS            4 small Nanomotors in a special mounting, tip holders. Resolution: atomic            4 Channel Network Controller (only for the 4 small Nanomotors)            Software and Interfacing to read the current signals from an external amplifier.</p>

Pos	Artikel
<b>3. Rotation and basic electronics equipment for stepper motors and path control:</b>	
13	Electronics: 4-Channel path control and 6 axis output drivers 19" subrack, power supply, interface electronics (to control up to 6 stepper motor axes) Reference- and end switch control (signal converter, line drivers, interfacing)
14	Software: Stepper motor module (as addition to NanoControl)
15	Rotary drive: 1 stepper motor rotary drive, endless rotation, with special platform for pattern recognition without shadows (incl. interface electronics) Adapter plate, current driver
16	Linear stage: 1 linear stepper motor (incl. interface electronics) Adapter plate, current driver
<b>4. Vision System:</b>	
17	Vision System, a set of CCD-cameras, electronics, vision software: 4 BW Video cameras 4 special objectives 4 holders, power supply, cables Vision software for pattern recognition Server software for remote control of the pattern recognition process by Ethernet Vision module for the process control program
18	Further options: 2 small BW inspection monitors
19	PC system: 1 high-end PC (optional) 1 Framegrabber card, 6 channels, with cable sets, software driver and realtime grabbing software
<b>5. Process control software ("Sequencer"):</b>	
20	Process control software with sequencer, communication with the embedded server PCs, the manual control program and the vision system
<b>6. Extension to the complete system with a base stage offering 350mm x 350mm stroke:</b>	
21	Base stage including scanning stage: High resolution scanning XY-stage 350x350 mm stroke, 160 nm resolution, with granite portal and electronics Adjustment of electronics and software of the scanning stage to be compatible with the Nanorobotics system Adjustment of the mechanics like height of the portal bridge, additional attachment points at the granite, air pressure distribution, fixing of existing adapter- and base plates, ... Assembly of additional components like: cable drag chains, cable channels, distribution points, ... Aluminium frame structure at the portal to carry additional equipment and cable channels control cabinet for 19" subracks

Pos	Artikel
	<b>7. Extension with an optical sensor for height measurements:</b>
22	Sensor of an FRT Microprof: 1 FRT "Microprof" - sensor with interface electronics Interface module and software for the Nanorobotics process control 1 high precision linear Z – stepper motor incl. holder for the FRT sensor and collision detection Adapter plate, current driver
	<b>8. Extension of the FRT – sensor to a complete external surface inspection system:</b>
23	FRT MicroProf: Base stage with 100x100 mm <sup>2</sup> stroke, control electronics and PC (the Microprof - sensor must be already included in the Nanorobotics system) Software Markt III
	<b>9. Individual software extensions (examples):</b>
24	Software for the production of 3-dimensional adhesive bonding lines
25	Software to place arrays of glue dots
26	Alignment of objects with closed loop feedback ...
	<b>10. Assembly of the complete system, setting-up operation, transfer, calibration, training:</b>
27	Assembly and wiring of the system, setting-up and matching of all components, testing Documentation, manuals Disassembly, preparation for transport, transfer On site assembly, wiring and start-up of the system Calibration of all components Training

The 10 functional groups of this Micro Production System can be realized one after another. Each extension leads to a new complete system with more facilities.

The first step includes a small microassembly stage, already with an extreme precision. When this core is not sufficient for the assembly anymore the system can grow step by step with the demands of the production.

We offer this modular design to reduce risk and cost for our customers. In the same way the usage of this complex Micro Production System can be learned with each extension step by step.