Park SYSTEMS

Data Sheet

XE–LCD™ Product Datasheet

Next Generation Industrial Metrology Solution for Flat Panel Displays

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Figure 1. The XE-LCD is a completely automated AFM/SPM system for inline characterization of flat panel displays.

XE-LCD Atomic Force Microscope

Atomic Force Microscopy (AFM) is emerging as an essential tool in many industries. With its ability to accurately measure critical dimensions in the micrometer to nanometer regime, the AFM is becoming a powerhouse in applications involving surface roughness, trench width, depth, sidewall slope, and linewidth characterization. Park Systems, a leader and pioneer in AFM technology, has changed the concept of AFM by introducing the completely automated XE-LCD for inline characterization of flat panel displays. Park Systems's mission is to provide our industrial customers with Advanced AFM/Scanning Probe Microscopy (SPM) products and solutions that extend the innovation of the XE-series to the industrial metrology of flat panel displays.

XE Interface Means Process Compatibility and User Convenience

The XE-LCD can be seamlessly incorporated as either an inline or offline inspection tool. The XE-LCD is a fully automated system that automatically finds optimal feedback parameters and scanning speeds for a given sample size and surface. Our engineers and scientists fully understand and have adopted the industry standard at every level of product development.

Park Systems is committed to the highest level of service and support, and every effort is made to understand our industrial customer's needs. We place the utmost importance on meeting promised delivery dates, guaranteed quality, and faithful after-sales service.

Automatic AFM Measurement

Our innovative vision system and pattern recognition algorithm enable fully automatic operation of AFM measurements so that you can focus on critical process issues. The optical video microscope automatically focuses itself on a sample or on a probing tip by recognizing the pattern of the cantile-

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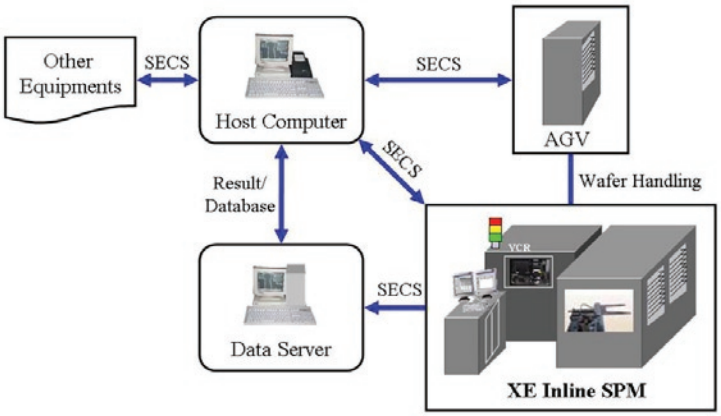
Figure 2. XE-LCD Inline Inspection Workflow.



Excellence in Nanometrology

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Figure 3. XE Inline System Control provides automatic wafer alignment, automatic height profiling, and data acquisition . It non-destructively provides highly repeatable and accurate measurements for step heights of LCD substrates.

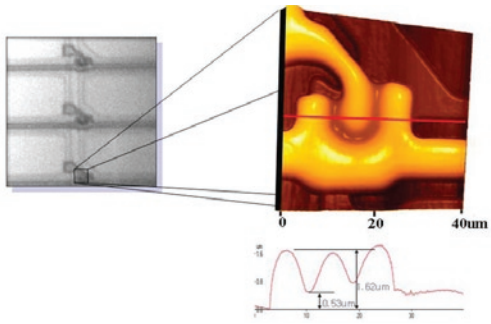

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Figure 4. The active vibration isolation system of the XE-LCD utilizes inertial feedback via electromagnetic transducers to cancel out floor vibration.

ver. The advanced navigation system with coordinate translation automatically locates the areas of interest, navigates to a desired measurement point by pattern recognition, and performs a measurement. COGNEX vision for pattern recognition is provided.

Automatic Glass Handling

The fully automated XE-LCD generates more accurate and better data in a non-destructive manner without the need for sample preparation. From loading to measurements, the XE-LCD is carefully designed to carry out your planned measurements without damaging flat panel substrate. Designed for use by operator-level fab personnel, the XE-LCD is class 1 clean room compatible, and includes XE Inline System Control with automatic panel alignment, automatic height profiling, and data acquisition. It non-destructively provides highly repeatable and accurate measurements for step heights of LCD substrates.

XE-scan System

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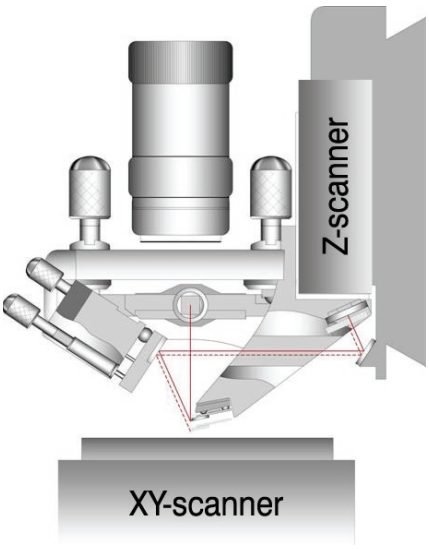
Figure 5. XE-scan System separates the Z-scanner from the XY, enabling exceptional Z-servo performance and scan accuracy. The innovative optical design allows for direct on-axis optical view of a sample from the top, the first and only AFM/SPM system to do so in the industry.



The XE-scan system is a core feature that gives the competitive edge to the XE-series over other AFM/SPMs. Park Systems's innovative scanner design separates the Z-scanner from the XY, enabling exceptional Z-servo performance and scan accuracy, unmatched by other AFM/SPMs. Both the XY and Z-scanner are designed to have great versatility.

Separation of XY & Z-scanner

The Z-scanner, which controls the vertical movement of the AFM tip, is completely separated from the XY-scanner which moves sample in XY horizontal directions. This structural change provides the user with significant operational advantages enabling true non-contact AFM.

Physical separation of the XY-scanner from the Z-scanner completely removes background curvature from the fundamental level, and effectively eliminates the cross-talk and non-linearity problems that are intrinsic to conventional piezoelectric tube based AFM systems. This uniquely designed XE-scan system not only increases the data collecting speed by at least 10 times compared to a conventional piezoelectric tube type scanner, but also improves the error due to the inherent non-linearity of the scanner itself.

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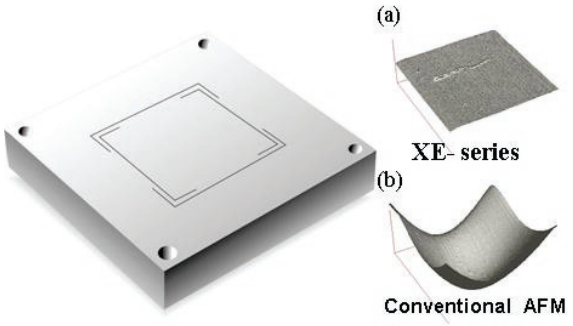
Figure 6. 2D guided flexure scanner of the XE-LCD enables high resolution imaging without background curvature. The raw data images of a bare silicon wafer are compared between (a) the 2D flexure stage and (b) conventional piezoelectric tube scanner. The outer plane motion of the 2D flexure stage is flat within 1~2 nm over the range of 15 × 15 mm while that of the conventional piezoelectric tube scanner is more than 80 nm.

High Performance Z-Servo

The Z-scanner, being separate from the XY-scanner, is designed to have a higher resonant frequency than conventional piezoelectric tube scanners. For this reason, a stacked piezo actuator is used for the Z-scanner, and it has a very fast response speed, at least 10 kHz, with a high push-pull force when appropriately pre-loaded. Since the Z-servo response of the XE-scan system is very accurate, the probe can pre-



cisely follow the steep curvature of a sample without crashing or sticking to the surface. This enables more than 10 times faster scan rates than is possible with a conventional piezoelectric tube type scanner, increasing the speed of the measurements, and protects the tip, resulting in the ability to acquire clear images for an extended period of time. A very high performance Z-servo system is required for NC-AFM. The mechanical response of the Z-scanner has to be extremely fast, a requirement met only by the XE-scan system.

2D Flexure XY-scanner

In the XE-scan system, the XY-scanner is a Body Guided Flexure scanner, which is used to scan a sample in the XY direction only. The flexure hinge structure of the XY-scanner guarantees highly orthogonal 2D movement with minimum out of plane motion. The 2D flexure stage of the XE-scan system has only 1-2 nm of out-of-plane motion for the scan range of 50 µm, compared to 80 nm by the tube scanner of conventional AFMs over the same scan range. Due to the Parallel Kinematics design, the XY-scanner also has low inertia and axis-independent performance.

The symmetrical flexure scanner design also makes it possible to place much larger samples on the sample stage than could normally be accommodated by a piezoelectric tube type scanner. Furthermore, since the flexure scanner only moves in the XY direction it can be scanned at much higher rates (10~50 Hz) than would be possible with a standard AFM.

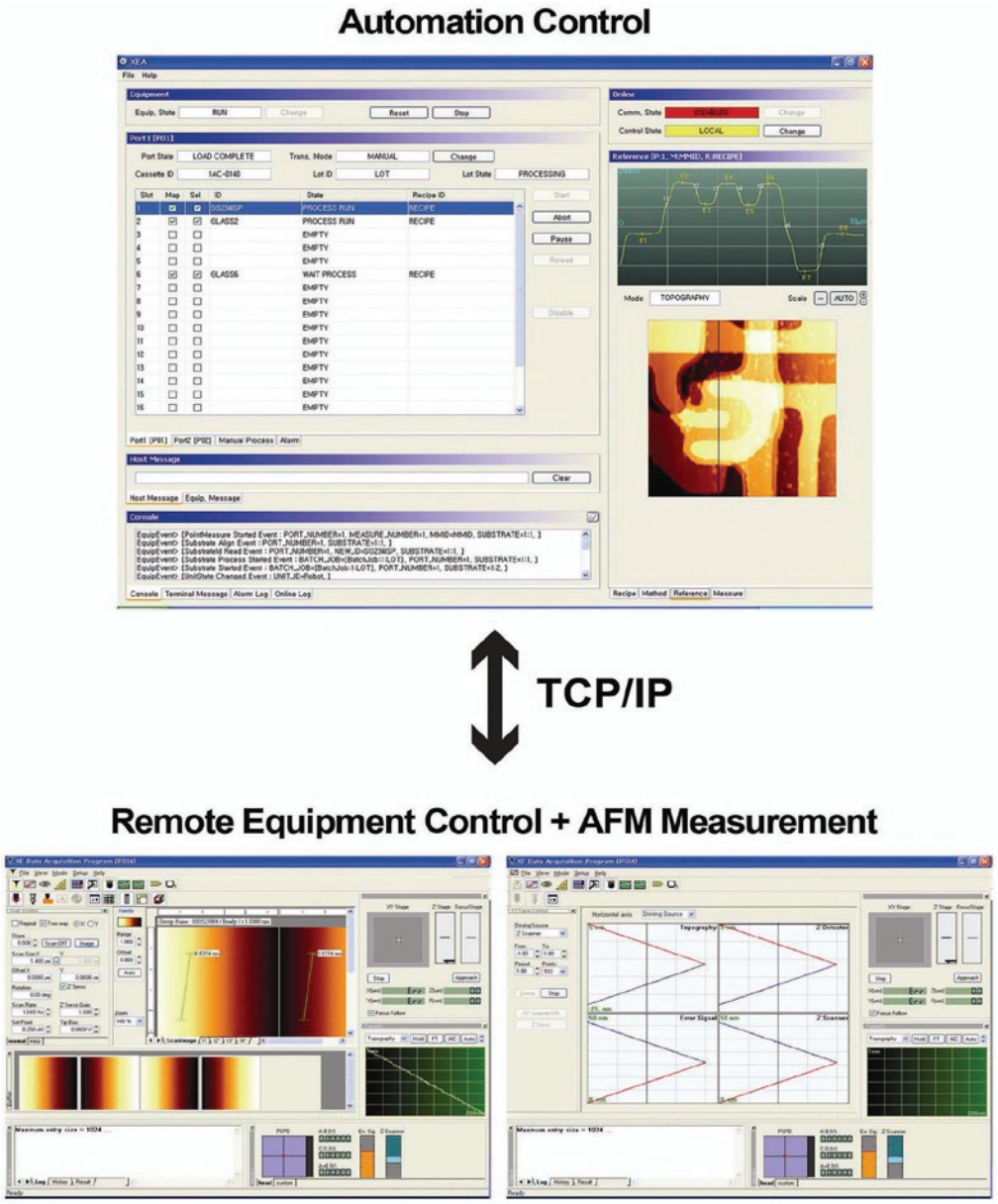


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Figure 7. XEA is the system software for automation that commands the XEP data acquisition software to carry out the AFM measurement of a sample following the preset procedure written in a Recipe file.

Electronics

The XE system is controlled by a state-of-the art DSP that empowers high speed and high capacity data processing. The XE incorporates advanced digital circuitry with precision software and hardware components to precisely control the XE-series. It is the most advanced AFM/SPM controller with superb features, functionality, flexibility, and expandability.

XE Software

XEP is a data acquisition program that communicates with the XE Control Electronics in order to control the XE-series system. The XEP interface allows a user to investigate and analyze a sample surface. That is, XEP controls and operates the XE system to collect sample data. Through XEP, you can select a wide variety of measurement modes depending on the properties of the samples you want to observe. Also, you can set or adjust several parameters in taking an image of your sample.

XEA is the system software for automation that commands the XEP data acquisition software to carry out the AFM measurement of a sample following the preset procedure written in a Recipe file. Supporting auto, semi-auto, and manual mode, XEA allows an operator to perform various system-wide functions such as editing a measurement method for each step of an automated measurement procedure, loading a recipe file, commencing the automated measurements of a sample, monitoring a measurement process, and obtaining measurement data.

XE-LCD Features	XE Performance Advantages
Automatic Measurement Control	Automatically finds optimal feedback parameters and scanning speeds for a given sample size and surface. The XE-LCD provides all other standard features of process control compatibility with SECS II, GEM, SMIF, and KLA-Tencor wafer map, etc.
Automatic Focusing System	Automatically focuses optical video microscope on a sample surface or onto a probing tip by recognizing the pattern of a cantilever.
Automatic Navigation System	Automatically locates the areas of interest, navigates to a desired measurement point by pattern recognition. COGNEX vision for pattern recognition is provided.
Automatic Glass Handling System	The XE-LCD is a fully automated in-line metrology system with capacity to handle large flat panel display substrates up to 1300 mm × 1100 mm.
Automatic Floor Noise Cancellation	Acoustic Enclosure The XE-LCD system includes a hermetically sealed acoustic enclosure, optimally designed for trend-setting high efficiency in blocking external optical and acoustic noise. Active Vibration Isolation System The XE-LCD system includes an active vibration isolation system which utilizes inertial feedback via electromagnetic transducers to cancel out floor vibration. There is virtually no resonance at low frequencies. Excellent low frequency damping is observed in the critical range of 0.7 Hz ~ 5 Hz. The system enables excellent directional and positional stability as well as isolation from building, acoustic, and motorized equipment vibration.
Advanced XE-scan System	Separated XY & Z-scanner No coupling between the XY plane and the Z-scanner completely removes background curvature from the fundamental level, and effectively eliminates the cross-talk and non-linearity problems that are intrinsic to conventional piezoelectric tube based AFM systems. Ultra High Force Z-scanner The key innovation that enables True Non-Contact mode in the XE-series. The ultra high force Z-scanner allows a significantly higher resonance frequency than those of conventional piezoelectric tube scanners. Since the Z-servo response of the XE-scan system is very accurate, the probe can precisely follow the steep curvature of a sample without crashing or sticking to the surface. This enables more than 10 times faster scan rates than is possible with a conventional piezoelectric tube type scanner. Hardware Closed-loop Feedback Hardware, not software, feedback is used to drive all the AFM signals in order to guarantee distortion free imaging. Hardware closed-loop position control allows for the absolute scaling of AFM measurements.
2D Guided Flexure XY-scanner	High resolution imaging without background curvature. This single module parallel-kinematics XY-scanner has low inertia and minimal runout, providing the best orthogonality, high responsiveness, and axis-independent performance.
Ball Screw Driven Z-Stage	5-phase stepper motor and backlash-free harmonic gear reduction provides reliable and swift operation.
Direct On-Axis Top Optical View	The direct on-axis optics is the first in the industry that revolutionizes the way AFM users view their samples by providing the natural on-axis view from the top with unprecedented clarity. The optical path from the sample to the CCD camera is a unobstructed straight line. This configuration provides much higher quality optical views than is possible with conventional AFMs.
XEA- Automation Control Software	XEA commands the XEP data acquisition software to carry out the AFM measurement of a sample following the preset procedure written in a Recipe file. Supporting auto, semi-auto, and manual mode, XEA allows an operator to perform various system-wide functions for automating measurement, data processing, and data reporting sequences.

SPECIFICATIONS

Operation Mode: Auto, semi-auto, and manual

Substrate
Glass: 1,100 × 1,300 mm
Cassette: InnoLux standard cassette

Mechanical
XY Stage: 1 mm resolution, ± 10 mm repeatability, 1,100 ×1,300 mm stroke
Z Stage: 0.08 mm resolution, £ 1 mm repeatability, 20 mm stroke
Automatic Navigation: Pattern recognition by COGNEX vision

Optical
On-Axis Optics: High resolution objective lens with 10× ultra long working distance, 0.64 mm × 0.48 mm field of view
Off-Axis Optics: 2 magnification objective lens, 3.2 mm × 2.4 mm field of view,
LED Illumination: up to 18 lm

AFM Scanner
XY-scanner: 100 µm × 100 µm range with closed loop feedback, full 16 bit resolution
Z Scanner: 12 mm range, full 16 bit resolution

Vibration Isolation
Velocity Feedback: Electromagnetic transducers
Frequency range: active 0.6 ~ 100 Hz, passive > 100 Hz
Active degrees of freedom: 6
System noise: less than 50 ng per root Hz from 0.1 to 200 Hz in all direction

Electrical
X, Y, Z Control Electronics: Closed-loop hardware feedback scan position control systems in all 3 axes
DSP control: 600 MHz DSP control (400 MFLOPS)
D/As: 21 channel DAC (4 × 16 bit, 10 × 12 bit) at 500 kHz settling,
A/Ds: 20 channel ADC (5 × 16 bit with MUX) at 500 kHz sampling
Computer-to-Controller Communication: TPC/IP

Software
XEA, XEP and XEI for automatic AFM control, data acquisition, and imaging.
Automatic navigation software with coordinate translation

Dimension
Main Equipment: 2,950 (L) × 1,900 (W) × 2,208 (H) mm
Electronics Cabinet: 850 (L) × 650 (W) × 2,208 (H) mm

Utility
Power: 1F, 220V or 208 V, 60 Hz (±10%), 10 KVA
Gas Line: Pressure 0.5 kg/cm^2, Swagelok (3/8 inch) fitting, 537 LPM capacity
Exhaust: Pressure < –20 mmAG, Flange (100A) Fitting, 5 CMM Flow volume rate
Vacuum: Pressure -80 kg/cm^2, Swagelok (1/2 inch) fitting, 500 LPM capacity

Operating Environment
Temperature: 18°C to 26 °C (Operating), 10 °C to 40 °C (Not operating)
Target Temperature: 22 °C ± 4°C
Temperature Change per Hour: 1 °C/hr
Humidity: Min. 35 %, Max. 90 %
Humidity Change per Hour: 5%/hr
Vertical Floor Vibration: < 1 × 10^{-8} m/sec for 0-50 Hz
Acoustic Noise Level: < 65 dB

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