PXI-Based Embedded System Controls Semiconductor Metrology Tool

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NI Products Used:
LabVIEW, LabVIEW Real-Time Module, NI-DAQmx, NI-VISA, PXI-1042, PXI-8145 RT, PXI-7344, PXI-6070E, PXI-6527, and PXI-8420/16

Pull Quote
James Kring, Inc., and EUV Technology produced an affordable system in less time by using PXI and LabVIEW Real-Time.

The Challenge
Developing a networked embedded control and measurement system for a semiconductor metrology tool to measure extreme ultraviolet lithography (EUVL) mask blanks.

The Solution
Using National Instruments LabVIEW Real-Time and PXI for embedded hardware control and LabVIEW for Linux to host the networked operator and supervisory graphical user interfaces on multiple touch-screen displays.

The Latest in Semiconductor Manufacturing Technology
The semiconductor manufacturing industry is actively evaluating new technologies to further reduce chip size and increase circuit density. Extreme ultraviolet (EUV) lithography is a new technology utilizing a shorter wavelength of light than traditional optical lithography to achieve the goal of smaller circuit traces. One critical component of the EUVL process is a mirror called a “mask blank,” which is coated with a nonreflective image (a “mask”) of the circuit to be projected and burned onto the chip. For the image to be projected evenly, the mask blanks must have a uniform and high reflectivity of EUV light across their entire surface. Because high-energy EUV light does not travel through air, this process must be performed, and any measurements taken, inside a high-vacuum chamber.

A reflectometer measures the reflectivity, and, thus, the quality, of the blanks by reflecting monochromatic EUV light off the blank and measuring the corresponding loss of intensity. The reflectometer varies the wavelength of light, sweeps through an entire target spectrum, and produces a reflectivity versus wavelength curve.

EUV Technology, a short-wavelength electromagnetic radiation utilization and analysis instrumentation manufacturer, asked James Kring, Inc. to partner in designing an embedded control and measurement system for an EUV reflectometer metrology tool used on a semiconductor factory floor. Touch-screen user interfaces would enable common tasks such as editing and running measurement recipes, viewing results, monitoring status, and servicing.
The tool control system manages the robotics responsible for transferring the mask blank from a standard mechanical interface (SMIF) pod into a high-vacuum measurement chamber, and the environmental control system of pumps, valves, and pressure gauges responsible for maintaining the high-vacuum environment. The reflectometer’s measurement system encompasses a laser, a laser-powered meter, EUV optical sensors, and a custom four-axis servo motor driver system that generates and monochromates the EUV light. The hardware system consists of approximately 10 RS232 serial devices, 40 digital I/O lines, two analog input signals, and four servo motion control axes.

Integrated PXI and LabVIEW Real-Time Provide a Powerful and Cost-Effective Solution
We chose the PXI-8145 RT embedded controller as the LabVIEW Real-Time control and measurement application execution target. It provided ample processing capabilities and integrated easily with a wide array of plug-in PXI modules. We selected the PXI-6527 digital I/O module for its isolated input/output capabilities and its ability to switch and monitor non-TTL level signals found inside the tool. We chose the PXI-8420 16-port asynchronous RS232 interface module for its LabVIEW Real-Time compatibility and ease of programming via NI-VISA driver software.

Each measurement iteration required synchronizing the EUV light source generation with the corresponding EUV detector measurement. With the PXI platform Real-Time System Integration (RTSI) bus, we tightly synchronized the laser firing with the analog input acquisition by sharing high-speed digital trigger signals directly on the PXI backplane. We used the PXI-6070E multifunction data acquisition module for its aforementioned digital triggering capability, its ability to easily meet the customer’s 1 MHz sampling rate requirement, and the ease of programming via NI-DAQmx driver software.

We chose the PXI-7344 motion control module to control the custom servo motor drivers which generated and monochromattted the EUV light source. We took advantage of the PXI-7344 for its ability to embed custom motion control programs written using NI FlexMotion VIs and run them directly on its own onboard processor. This feature was instrumental in controlling the reflectometer’s reel-to-reel constant-tension tape drive, a critical component in the EUV source-generation process.

LabVIEW Real-Time Shortens Development Time with Remote Development and Debugging
Traditional embedded system development requires many tedious, manual steps. For example, after developing the source code, the user must be compile it and transfer it onto the embedded system. Then the user must test and debug the application, often requiring special debugger cables to be hooked up between the embedded system and the debugging PC. If software changes are required, the user must repeat the process until achieving the desired result.

However, with LabVIEW Real-Time targeting our embedded PXI controller over the network, these steps were completely transparent, dramatically reducing testing and
debugging time. We used LabVIEW for Windows to rapidly develop our control and measurement application, and we used the LabVIEW Real-Time Module to upload, execute, and debug our application on the PXI-8145 controller real-time operating system.

LabVIEW also provided a powerful suite of TCP/IP VIs for developing the communications portion of this distributed control and measurement system. The embedded PXI application managed low-level hardware and measurement control, while the LabVIEW for Linux applications running on the touch-screen terminals performed high-level operator control and measurement analysis. We customized existing NI TCP/IP client/server software to develop a truly distributed system with three networked subsystems messaging control, status, and response data via Ethernet.

**Cost-Effective Solution Affords Increase in Productivity**

James Kring, Inc., and EUV Technology produced an affordable system in less time by using PXI and LabVIEW Real-Time. We realized a significant increase in software productivity by utilizing the advanced embedded system debugging tools of LabVIEW Real-Time and the ready-to-use data acquisition, motion, networking, and analysis VIs that ship with the LabVIEW development environment. Using the PXI hardware platform meant we could focus on customer performance requirements and simply choose the appropriate plug-in modules to get the job done. Should the system evolve, we can easily add hardware and enhance the software using the flexible and scalable PXI and LabVIEW Real-Time platforms.

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<<<<<<COULD NOT GET CONTACT INFO ONLINE>>>>>>