Automation Control for Wet Processing Equipment

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Advantages

- **Maximum Flexibility** — Easy synchronization to upstream or downstream machines or processes
- **Quick Operational Parameter Access** — Operator interface used to select and store operational parameters and set points
- **Faster Development/Troubleshooting** — Pre-built and tested Add-On-Instructions (AOI) with Human Machine Interface (HMI) faceplates provide detailed diagnostics
- **Data Access** — Information enabled code structures pre-built for quicker implementation of data collection needs such as Overall Equipment Effectiveness (OEE), production scheduling and historical process data

Batch Process Wet Bench

- **Integrated Motion** — One development environment for motion and control
- **Reduced Downtime** —No homing required after a power failure by using servo motors with absolute encoders
- **Modular Code for Batch Processing** – Equipment Modules, Control Modules, and State Machine structure offers code re-use and simple customization of steps

Continuous Inline Processing

- **Integrated Drive Control** — Pre-built and tested AOIs and HMI faceplates speed deployment of networked drives
- **Process Optimization** — Advanced Process Control (APC) capabilities and closed loop process control improves process consistency and line stabilization

Overview

Wet processing equipment is used in various stages of the solar panel manufacturing process. Panels manufactured using crystalline silicon technology (solar cells built on silicon wafer substrates) use wet processing equipment in both the wafer production and the cell production areas. The wet process steps are generally categorized as cleaning, etching, texturing, rinsing, drying and electroplating. These steps are carried out using either a batch process via wet bench equipment or a continuous process via inline process equipment.

Batch and continuous wet processing equipment require facility tie-ins to de-ionized water, chemical delivery/blending systems, clean dry air systems, waste recovery systems, exhaust scrubbers and utility drainage systems. Special gas detection and leak detection monitoring may be needed depending on the toxic or corrosive nature of the chemicals or gases used.

Batch Process – Wet Bench Equipment

Wet bench equipment consists of one or more chemical and rinse baths and a drying system. A robot is used to automatically pick up carriers loaded with silicon wafers and move them through the chemical and rinse baths and then through the drying station.

Carriers can be processed one at a time sequentially or multiple carriers can be processed simultaneously. If multiple batches are processed, the recipes run and the scheduling of robotic moves become complex. Scheduling software is needed to process the batches when bath process times may not be balanced or when batch recipes vary. Presence sensors to detect carriers and encoders are needed to allow the robot to precisely position the carriers.

There are many options for the configuration of wet bench equipment including the number of chemical and rinse baths and support for acids, bases, and solvents. Agitation is achieved by either ultrasonic or megasonic energy. Electric current is used in the plating process. Chambers for pre-heating and cooling down the wafers may be included.

Drying technology options include quick dump rinser, spin dry, IPA or Marangoni. Monitoring systems for pH levels and chemical and gas concentrations help prevent toxic materials from entering water drains or venting into the atmosphere.

System control usually includes a Programmable Automation Controller or Programmable Logic Controller (PAC or PLC), industrial computer running HMI software and some include a dedicated operator interface panel. The controller runs recipes that include parameters indicating the operational steps to be performed, the baths to use, the time to drain and refill the bath, temperature set points, spray and rinse cycles, and the endpoint detection method either by the step iteration count or the concentration of the drain water. The carriers are moved from bath to bath with a servo motion controller executing moves in the x-z plane. Rotary servo axes are transitioned to linear motion by means of linear actuators.

The industrial computer handles the recipes and the individual carriers' schedule as they progress through the baths. Operators use graphical displays with real time data to monitor and control the equipment. Process engineers can view both real-time and historical trends of critical process parameters such as temperature, concentrations, pH levels and processing time as these points are logged to a historical archive.

Continuous Process - Inline Processing Equipment

Inline processing equipment is similar to an automated car wash, except wafers are processed and move down the line on conveyors instead of vehicles moving along a track. Multiple rows of wafers lay horizontally on the conveyor and move through several sections where different processing steps are performed.

Similar to batch equipment, inline equipment can have many configuration options. There are usually options for the number of chemical, rinse, and dry sections as well as the support for different chemicals used within a section. Optional ultrasonic cleansing or electrostatic potential for plating may be used. Drying technology options include an HF/O3 process and continuous hot air dryer/blowers.

Monitoring systems for pH levels and chemical and gas concentrations help prevent toxic materials from entering water drains or venting into the atmosphere.

Inline systems generally use a PAC/PLC and operator interface or they connect into a production line SCADA HMI system.

A Variable Frequency Drive (VFD) controls the conveyor speed and can be adjusted via the HMI. VFDs can also control the pumps used to immerse the wafers in a bath and limit damage to the wafers.

Rinsing after each chemical process step minimizes the transfer of chemicals along the conveyor. Resistivity level, water feed and flow monitoring are all critical to the success of the rinsing process. Blowers or air jets dry the wafers and prevent droplets from leaving marks/residues on the wafer.

The SCADA HMI performs the data logging of process parameters including temperature, concentrations, pH levels, flow rates and conveyor speed. Real-time data and historical trends are shown on graphical displays used by operators for monitoring and control. Process engineers can use displays to compare current operational parameters against historical golden runs.

Solution

Rockwell Automation offers solutions to help monitor and control batch and continuous wet processing equipment. Central to the solution for wet processing equipment is the Rockwell Automation Integrated Architecture™. Integrated Architecture brings together a powerful multi-disciplined control engine, seamless networking, a scalable visualization platform and the information technologies needed to help you lower your Total Cost to Design, Develop and Deliver℠ a machine.

Unlike conventional control architectures, Integrated Architecture provides fully integrated, scalable solutions using a single control platform and a single development environment. Machine builders can re-use engineering designs more efficiently to help reduce development time and cost and enhance business performance.

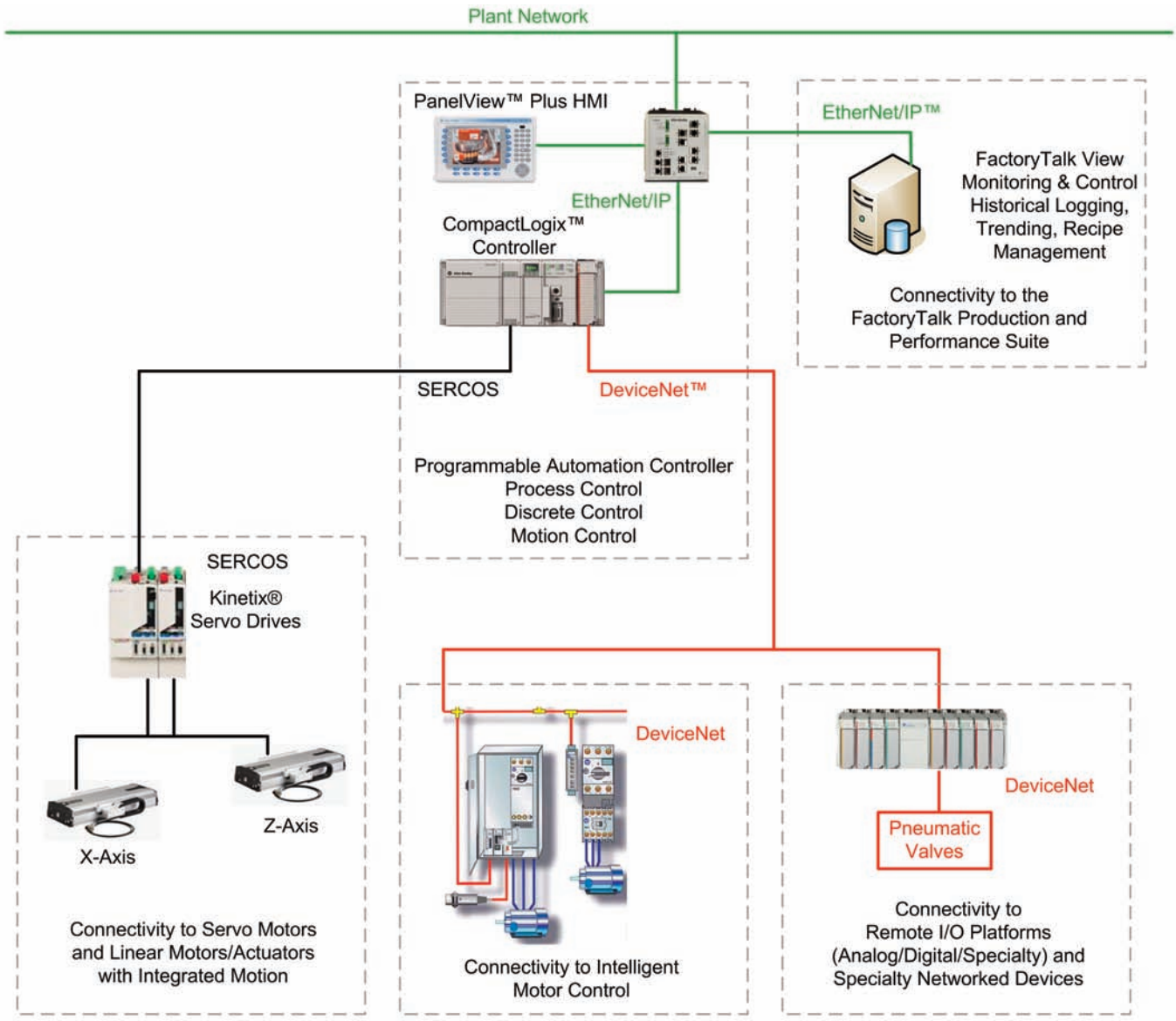
Batch processing equipment utilizing servo motion can take advantage of the Kinetix® integrated motion control and process control capabilities within the Allen-Bradley® CompactLogix™ PAC.

Continuous inline processing equipment can take advantage of the process control capabilities and integrated networked drive control within the CompactLogix or ControlLogix® PAC.

Modules included within the Rockwell Software® FactoryTalk® Integrated Production and Performance Suite can be used to present the critical data necessary to monitor and control the wet processing equipment. Data collection, historical logging of process parameters, real-time trending and enhanced diagnostics are capabilities that can be deployed to help improve equipment operation.

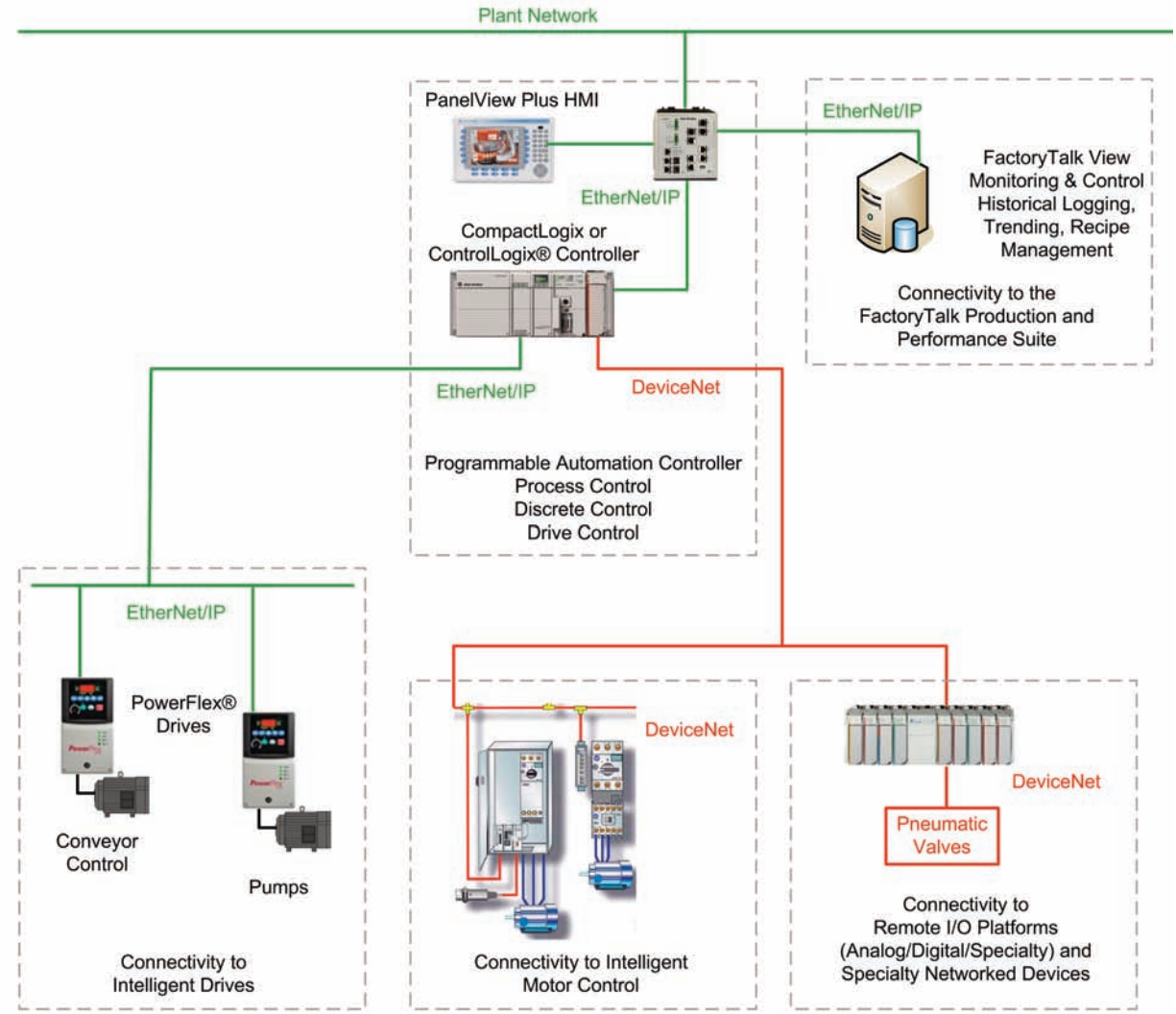
Typical Architectures

Batch Process – Wet Bench Equipment



Typical Architectures

Continuous Process - Inline Processing Equipment



Rockwell Automation solutions helps deliver improved production capabilities and reduced total cost of ownership by providing unparalleled functionality, flexibility and scalability. Machine builders can respond quicker to customer or market demands, reduce maintenance costs and downtime and easily gain access to actionable plant and production information for improved management and decision-making.

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