Mattson Wet Products GmbH uses New Automation Technology

AWP300: Mattson Automatic Wet Processor for 300 mm wafers

CANopen in semiconductor manufacturing

Whilst fieldbus systems like Profibus and DeviceNet are generally chosen because the favourite control system comes with this interface, the decision for CANopen is more technology driven. Engineers look for an open, reliable communication system that can be tailored for the specific application needs and is easy to implement on special function devices that are not available with fieldbus connectivity yet. They are fascinated by intelligent medium access control method and the built in error detection and control mechanisms provided by the Controller Area Network technology and then look for an appropriate application layer. They find that CANopen takes advantage of the various CAN features and is readily available in a wide range of devices.

Mattson Wet Products GmbH is a world-wide supplier of semiconductor manufacturing equipment that pretty much followed this route. Having used CANopen with VME systems in selected lines before, Mattson decided to introduce PC based controls as their next generation control architecture. And CANopen was chosen to be the communication system. Mattson launched a full scale evaluation project and finally chose Beckhoff as main supplier for both hardware (Industrial PCs and fieldbus I/O) and software (TwinCAT control system). Mattson later stated that Beckhoff's CANopen expertise had an important share in this decision.

Mattson Wet Products is specialised in the wet process of semiconductor manufacturing. After each lithographic production step, the wafers have to be etched, flushed and cleaned. Reliability of controls and communication is crucial in this application: if a system breakdown may cause the tray of wafers to be left in the acid for too long, this obviously would destroy the entire tray load. The resulting damage might exceed several million USD, depending on the number and type of wafers that have been destroyed. Therefore Mattson use a bus system that due to the CAN technology provides significant leeway for electromagnetic noise and disturbance.

300 mm wafers in process

Position control with CANopen

Mattson first introduced the Beckhoff CANopen technology in the products AWP300 and the KRONOS™300 which are processing 300mm wafers. All Mattson machines are fully modular designed. According to the customers' requirements the number of process units and tanks varies, and so does the software. Within the AWP300 and the KRONOS™300, a 500 kbit/s CANopen network connects the PC controller with several servo axes, fast I/O modules and a Control Panel. Less time critical I/Os, valve manifolds, control panels and special function devices like megasonic and ultrasonic systems use a second CANopen network with 125 kbit/s. In total there more than 500 discrete and 50 analog I/O channels. The drives close the position control loop locally on the drive controller. Therefore the main controller just has to transmit new position commands whenever a new motion segment starts. In order to start several axes simultaneously, the position command Process Data Objects (PDOs) are communicated using the CANopen sync mechanism. The resulting transmission type for these PDOs is "0", where the PDO is sent only when the data has changed but is set valid at the next following SYNC message. As the main controller closely supervises the resulting drive motion path, the actual position data is communicated in a cyclic synchronous PDO (transmission type 1). The digital I/O data is sent in the event driven communication mode: whenever an input or output changes, the resulting PDO is transmitted. This leads to short reaction times combined with minimal bus bandwidth utilisation. In order to avoid a "flooding" of the bus due to ever changing analog signals, the analog data is sent cyclically, triggered by the sync telegram. Slow changing analog values such as temperatures are communicated every second, third or fifth sync message, making use of the tuning mechanisms of CANopen that allow one to make best use of the available bandwidth.

In the AWP300 and the KRONOS™300, Mattson finds typical busloads of 30-40 % that leave enough bandwidth for unlikely but possible bursts of event driven messages and for acyclic parameter communication using Service Data Objects (SDO). Mattson uses the Beckhoff two channel PCI CANopen card FC5102 that constantly measures the busload and provides the actual value in a variable in the process image.

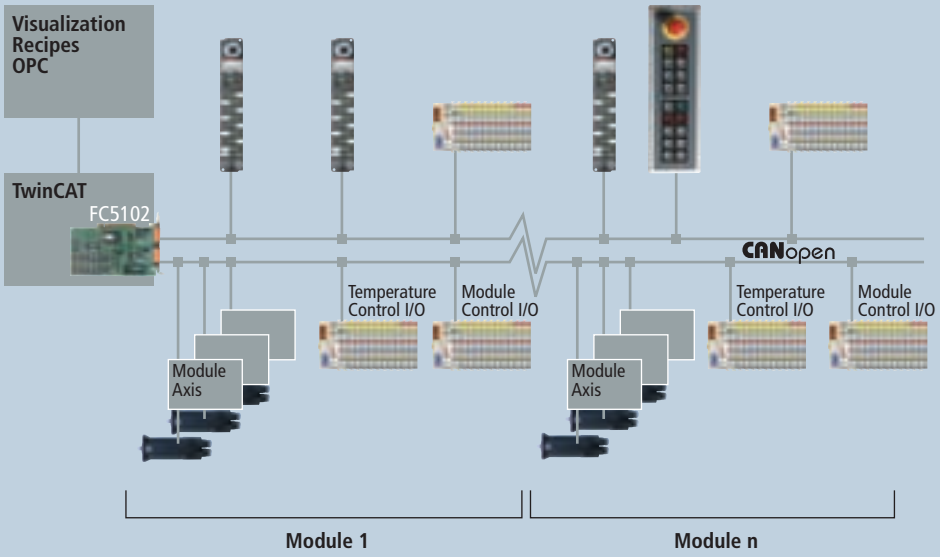
Four PLC run-time systems on one PC

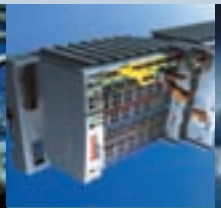
The TwinCAT application program written in IEC 61131-3 languages (mainly structured text) has to fulfil many tasks: besides the mechanical wafer handling, fluid and temperature control and tool supervision an important job is to trace all process steps and store that data in an Access data base. As the process requires constant adaptation of the acid composition, formula management makes up for a large proportion of the software. The tool controller runs 4 software PLCs simultaneously, each of them consisting of several tasks. The source code of the control application exceeds 4 Mbytes of data and uses around 150,000 variables, not counting the visualisation application.

A second PC unit is used for visualization as the SCADA package requires significant processing power. Both PCs are linked via Ethernet and TCP/IP and OPC is used for data exchange with the tool controller application. More than 7 500 tags indicate the large size of the visualization application and the extensive use of the OPC interface. Interestingly the OPC server runs on the visualization PC and not on the tool controller: the Beckhoff ADS communication via Ethernet that transports the data from the tool controller application to the OPC server is much faster than an OPC connection via TCP/IP.

Software temperature controller replaces hardware

Beckhoff developed a self tuning temperature controller with integrated sensor supervision system that now controls the liquid temperatures in the various tanks of the plant. The algorithm for determination of optimal controller parameters greatly simplifies the process of commissioning the controller. The controller has





been implemented as a software function block so that multiple instances can be generated. The control algorithm itself is PID-based with an additional pre-regulator that can be inserted to minimise overshoot. It operates independently of whichever fieldbus and sensor/actuator system is installed. All parameters can be observed directly in the software PLC for diagnostic purposes. These parameters can, moreover, be displayed in the visualisation system, and linked to other function blocks in the PLC. By using this software temperature controller Mattson replaces a number of dedicated hardware temperature controllers and thus considerably reduces the hardware footprint. In semiconductor manufacturing equipment size does matter as clean room environment is expensive.

I/O systems for CANopen in protection class IP 20 and IP 67

Small footprint, high protection class and fast wiring were decisive for the use of the Beckhoff Fieldbus Box series. The product line consists of the stand alone Compact Box, the Coupler Box and the Extension Box modules. The modules meet the Protection Class IP 67 and are wired using either pre-moulded cord sets or field-wireable connectors.

Together with the IP 67 Fieldbus Box Mattson has selected the Beckhoff IP 20 Bus Terminal series. The Beckhoff CANopen I/O products provide full CANopen functionality: up to 32 PDOs support all transmission types. Variable mapping, boot up message and comprehensive diagnosis via emergency message are additional features. The parameters can be stored in non volatile memory. Smart PDO triggering through delta functions and limit value settings for analog inputs allows one to fine-tune the bus bandwidth utilisation. FLASH upgradeable firmware gives easy access to new features. All bus couplers come with an additional serial interface for configuration, but all parameters including the settings of the intelligent terminals are accessible via CANopen SDOs as well.

In 2001, Mattson delivered the first tools which are equipped with the new AWP300/KRONOS™300 software and electronic concept based on Beckhoff's New Automation Technology. The electrical design team of Mattson found that the setup time for the electrical installation equipment was reduced by 70 % since they use the Beckhoff equipment.

www.mattson.com