The Integration of Add-on Sensors into the Manufacturing Tool Environment – Recent Models and Future Needs

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Sensor Integration

- **Aim**: The unification of tool and sensor data together with process data like LotID, Recipe etc. is important.
- **Problem**: The manufacturing tools are not equipped with a standard data interface. The integration of add-on sensors causes problems. The EDA interface is not usable for the integration of add-on sensors.
- **Recent situation**: IC manufacturers have not seen the necessity of a standard data interface. The integration of add-on sensors is necessary to analyse time critical data and merge the data off-line.

EDA and Sensor Interface

- **EDA interface** would be linked to sensor bus and field bus of tool data.
- **The same interface** for sensor data and tool data would be usable.
- **The EDA interface** does not replace the sensor interface which is necessary to couple the data to the tool.

Demands on Sensor Interface

- **For high volume production**: Data reduction is necessary for analysis. Because of high speed data transfer, Automatic Data Analysis for APC is strongly recommended.
- **Transfer of logistics**, e.g.: LotID, Recipe, Process Step, WaterID. Logistics are necessary for identifying the data. Data without logistics are not usable for APC.
- **Process step** should be known because: Sensor may need logistics for measurement (optical sensor). Data without logistics are not usable for APC.
- **Sensor Network** - The gateway is connected to a Sensor Network. The internal field bus of the tool is expanded by a gateway.

Recent Models applied in Fabrication

**Box as SECS path-through**

- The box is a host computer working as SECS or EDA path-through.
- The box has a sensor bus with a standardized or proprietary protocol.
- Sensor data and tool data are merged inside the box.
- Boxes integrated in the tool are already available.
- The box solution is recommended for an easy and fast sensor integration.

**SECS**

- Sensor has a SECS interface behaving like a tool.
- Transfer of logistics not standardized. A proprietary solution is required.
- Time synchronization between sensor and tool data is necessary.
- Effort to develop host program and data merging is required.

Proprietary Sensor Interface

- Few equipment suppliers offer a sensor interface, e.g., LAM.
- No further effort to integrate an add-on sensor if sensor supports the protocol.

Internal Sensor Bus of the Tool

- The internal field bus of the tool is expanded by a gateway.
- The gateway is connected to a Sensor Network.
- No logistical data available because the field bus does not support the logistic transfer.

Applicable Communication Standards according to E54

**Modbus/TCP E54.9**

- Add-on sensors are connected to a Modbus network.
- The network is managed by a host which is not connected to the tool.
- Caution: Modbus does not mean compliance to E54 automatically.
- Object Messaging Protocol should be supported (FC 91).
- The effort required for implementation is lower than for Ethernet/IP.

**Ethernet/IP E54.13**

- Transfer of control and information messages
  - Control message: short, fast, unacknowledged message transferring real-time data, e.g., sensor data. Transfer via UDP.
  - Information messages: longer, error ensured, non-real-time message, e.g., configuration and diagnostics. Transfer via TCP.
- CIP makes use of abstract object model.
- Consumer – Producer Architecture: Producer sends messages as a broadcast. The interested consumers read the message.
- Sufficient functionality implemented (i.e. time stamp, heartbeat).
- Configuration is carried out via a device description file (EDS Electronic Data Sheet).

**Profinet E54.14**

- Consumer – Producer Architecture is based on Profinets DP.
- Profinet allows direct interfacing of decentralized sensors on the Ethernet.
- Configuration is carried out via a device description file (GSD).
- Coupling with Profinbus via a proxy is possible.
- Sufficient functionality for use in semiconductor production has been implemented.

Summary

- APC without using data of smart sensors will not reach higher quality.
- Manufacturing tool must be equipped with a sensor interface to connect add-on sensors in future. Tool specification has to be changed.
- The sensor interface of the tool must be based on Ethernet in compliance with SEMI E54.
- Sensor data and tool data unifying the process tool is the best solution.
- The EDA interface must deliver tool data and sensor data together. The sensor data appear as coming from the tool.
- Tools with sensor interface for add-on sensors are available, e.g., LAM.
- The Box meets the demands on a sensor interface. The installation is very easy.

Perfect Plasma Control