

Feintool: PC-based control system for highly flexible "modutec" assembly platform

Modular assembly and control concept



→ The mobile phone market is a fast-moving business, dominated by technical innovations and fashion trends. Products – and therefore production – usually change after less than twelve months. Thanks to the highly flexible "modutec" assembly platform from Feintool Automation, the time and costs involved in such a changeover, for example for the assembly of mobile phone cases, can now be reduced significantly. The modular concept is based on powerful automation and communication technology, which Feintool realizes with PC control technology from Beckhoff networked via Ethernet.

Feintool's approach involving the highly flexible assembly platform is very innovative: "modutec" is offered both as a turnkey system for end users or as a fully modular system for assembly automation facility manufacturers or OEMs. The modular platform offers flexibility throughout, from the mechanical base unit to the process modules and the control concept.

Feintool Automation AG based in Aarberg/Switzerland produces the basic modutec infrastructure. Customer-specific assembly and commissioning of the overall system is dealt with on site. In addition to Feintool Automation AG in Aarberg, the Feintool Automation division includes IMA Automation GmbH in Amberg (Germany) and Feintool Automation Berlin GmbH (Germany).

Hans-Rudolf Helfer, development manager at Feintool Automation, explains: "Like the 'clittec' rotary indexing machines for the installation of small and very small parts (up to a size of approx. 100 mm), the 'modutec' linear transfer system benefits from Beckhoff control technology, which accounts for about 80% of our control systems". "In addition to rotary indexing machines, we also make increasing use of other variants, such as high-speed systems. We utilize the synergies within the automation division by using the 'modutec' assembly platform,

which consists of a small number of standardized components and highly expandable independent stations."

Thomas Ernst, project manager at IMA Automation, explains: "For customer-specific projects, we obtain standard 'modutec' components from Aarberg, i.e. the station line consisting of the basic unit, supplementary units, enclosure, controller and basic software. We then implement the customized assembly system for the respective product, in this case mobile phones."

Module "recycling" and fast commissioning

"The big advantage of 'modutec' – and a primary aim of our current customer – is reusability of the modules," said Thomas Ernst. "Cycle times in the mobile phone market are typically less than twelve months. After that, products tend to be discontinued. Especially the design components of mobile phones keep changing." This "trend awareness" particularly applies to mobile phone covers, and our new system is used to assemble these "shells". Thanks to "modutec", up to 70% of system components can be re-used, i.e. for a product change the complete plant is dismantled and re-assembled. In addition to the cost factor, this saves

about 50% of changeover time. While previously assembly took about half a year, it can now be done in about three months.

Commissioning times are also reduced significantly, because several standard processes are clearly defined from the outset and don't change much during the construction phase. Thanks to the modularity of the system, these processes can be taken out of the production line and optimized in stand-alone mode. Thomas Ernst said: "This enables us to regard every single process as a separate system and to test it independent of the overall process. The control architecture also supports this approach, because with the CX1000 from Beckhoff each process has its own independent controller, which is networked with other controllers and with the higher-level PC-based system control, i.e. the master computer. In the final step, the system is tested as a whole."

The production process

The system for assembling the mobile phone covers comprises four standard modutec station lines, three manual workstations and a master computer. Each station line may involve up to eight processes (each based on a 450 mm wide process plate) or up to four 900 mm process plates. The two types may be mixed as required. Notwithstanding the high complexity of the production process, with a conveyor speed of the linear transfer system of 15 m/min the system achieves a cycle time of approx. 3.3 seconds per workpiece carrier.

The mobile phone covers are "born" at the end of the first modutec station line, i.e. during the fifth and last process involving palletizing the empty cover.

The second station starts feeding in metal screens from blister belts for protecting the earpiece. The metal screen is then ultrasound-welded to the cover. An infrared window, also provided by blister belts, is then inserted on the side via a sophisticated mechanical handling system (cylinder units). During the same process, the system measures the stamped and bent part for protrusion via an



Mass-produced composite plastic/metal components from Feintool assist with control tasks: connectors, sensors or switches. Dozens of individual components are assembled into cost-effective end products using Feintool automatic assembly machines: mobile phones, disk drives or measuring instruments.





Powerful automatic assembly machines handle assemblies and end products with cycle times of 1 to 2 seconds and with automatic function control. "modutec", a highly flexible and modular assembly platform, offers previously unheard of expandability and reusability at station, process module, controller and enclosure level. Setup and changeover times for semi or fully automatic assembly are reduced drastically.

electrical continuity test. The most difficult processes starts in the middle of the second modutec station line, i.e. application of several adhesive labels for fixing design components at a later stage. The mechanical system for the two circular tables that are required is very complex. In addition, the system features two image processing systems for measuring the position of the adhesive pads.

In the next step – and in the next modutec station line – the viewing window is introduced, and the design component (which is pre-assembled on the circular table by two robots), consisting of an elaborately painted and chromium-plated plastic part, is fitted to the adhesive pads. The third modutec station line closes the case by pressing it and checks that it is locked correctly.

In the fourth modutec station line, the protective foil for the display is applied without bubbles, and the component is turned. A foam frame is then introduced as a buffer for the display and placed by a Scara robot (which is controlled by an image processing system) with an accuracy of five hundredth of a millimeter. In the subsequent three manual workstations, the device is subjected to a 100% visual inspection, focusing mainly on paintwork deficiencies and small damage caused by workpiece handling. Subsequently – once the components have reached modutec station line 1 – the data codes are applied via CO₂ laser. Good parts are then palletized, and rejects separated.



The Feintool Group

The Feintool Group with head office in Lyss/Switzerland comprises the divisions "Fineblanking Technology", "System Parts", "Plastic/Metal Components", and "Automation". Feintool is a leading technology and system supplier for fineblanking/forming and assembly/automation, and a global supplier of metal and plastic components. Feintool has around 1,700 staff at facilities in Switzerland, Germany, France, Italy, Great Britain, the United States, Japan and China, about 900 of whom are based in Switzerland.

→ Feintool www.feintool.com



Hans-Rudolf Helfer,
development manager at
Feintool Automation.



Control station of the
production line, consisting of
a control cabinet PC C6140 and
a Beckhoff Control Panel.



Thomas Ernst,
project manager at IMA
Automation.

The control technology has to be compact and fast

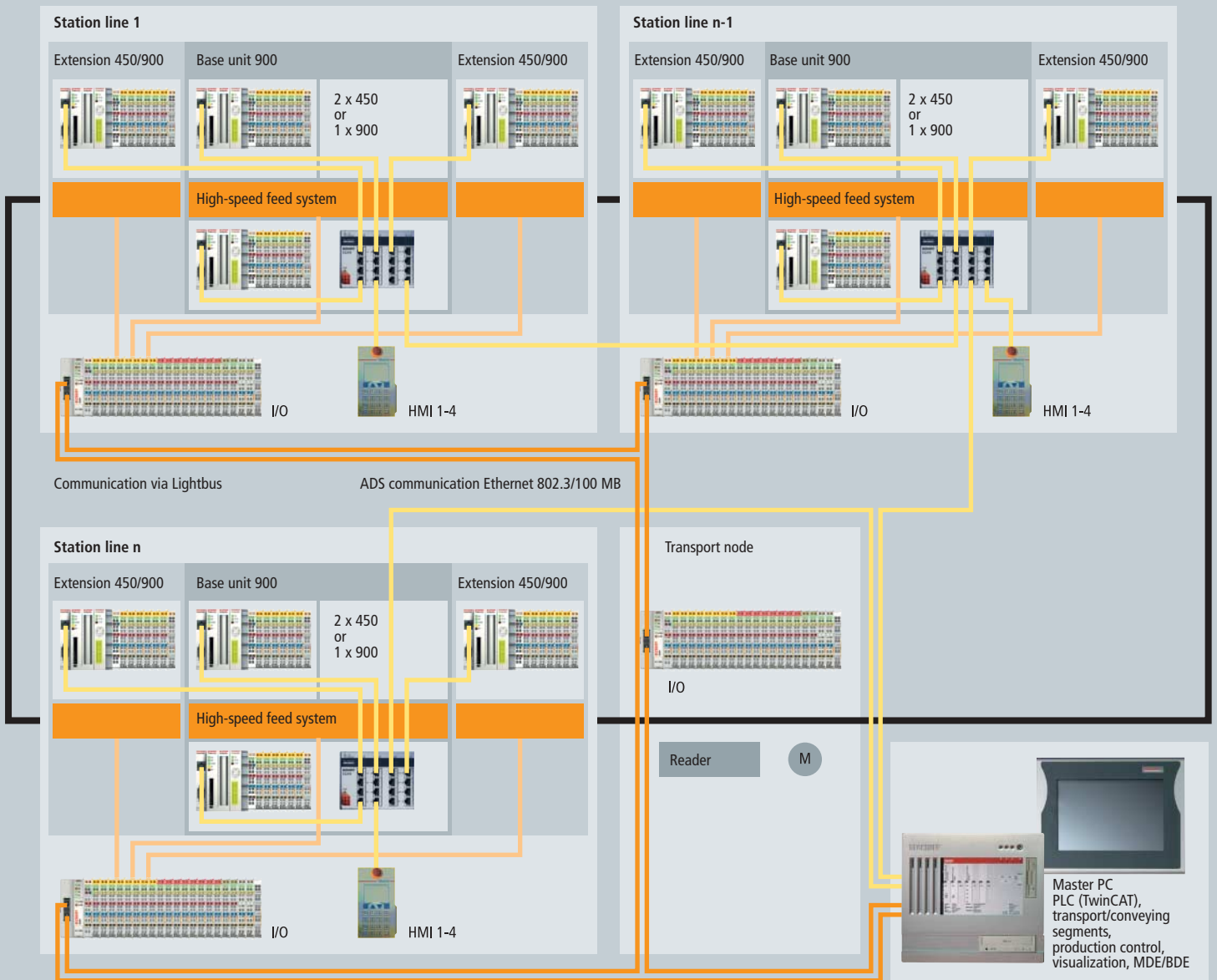
The decision by the "modutec developers" to use Beckhoff control technology for this complex production process had many reasons. One of the main reasons was the compactness and performance of the CX1000 Embedded PC. Another factor was the diversity of the I/O modules in the form of Beckhoff Bus Terminals, which can be connected with little effort and enable quick and simple system configuration. "Moreover, the CX1000 integrates PLC and motion control functionalities in a single system", said Hans-Rudolf Helfer. "Each process module uses its own control computer. Space is tight (especially with the 450 mm process plate), so that compact design offered by the CX1000 is a crucial factor."

Thomas Ernst added: "In terms of performance the CX1000 has also met our expectations, because it can reduce the cycle time down to 1 ms". For our applications this is often very important, since we have to achieve high positioning accuracy, for example for component feeding. Processing times of 12 or 15 ms, which is the best some other controllers can offer, would reduce precision significantly. A further advantage is trouble-free commissioning even for heterogeneous systems, because for interfacing of external components such as robots, DeviceNet, PROFIBUS and serial connections are used in addition to Ethernet networking."

IMA themselves switched to Beckhoff technology about 5 years ago. Thomas Ernst said: "At the time, we were looking for a PC control system and quickly ended up with Beckhoff, where we found a wide range of PC controls and operating panels. The I/O components from Beckhoff also proved to be ideal for our purposes. One example is the fast and convenient to handle Lightbus, which we use for our clictec systems, the modutec version for rotary indexing systems. Meanwhile, we have also realized our own standard machine data acquisition via the TwinCAT automation software. We are also very satisfied with the clarity of the programming, especially since our programmers have become very familiar with the Beckhoff systems by now. For all these reasons, we offer Beckhoff technology as standard for new projects."

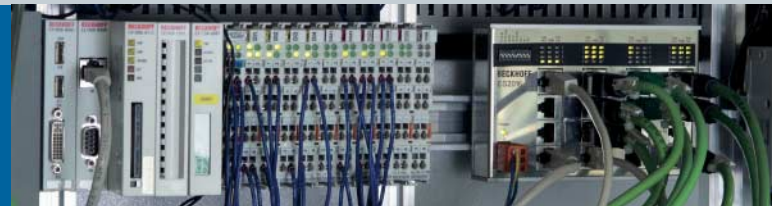
Data exchange via Ethernet

The assembly system for the mobile phone cases heavily relies on automation: The production line is monitored via a control station consisting of a control cabinet PC C6140 and a Beckhoff Control Panel. This line computer – with Windows 2000 Professional and TwinCAT – runs the complete transport/logistics control system, the software for which was developed in-house by Feintool Automation and is used for realizing all type and order management tasks, machine data



acquisition, statistical evaluations, and error message generation. The master computer communicates with the station line computers, which deal with tasks such as control of protection circuits, transfer of information to the operating panel of the station line, providing information for the individual processes, managing IP addresses, and organizing network communication. TwinCAT is used on all Embedded PCs – a total of 17 CX1000 computers.

Network communication for this production line is realized via standard Ethernet. This is necessitated by the large data quantities requiring fast transfers. Within the short cycle time of 3.3 s per housing shell, several handshakes have to be processed, and the high-speed feed system – another Feintool Automation “modutec” module developed for fast workpiece transport within the station line (less than 1 s change-over time at 460 mm lift) – also generates a large number of



handshake signals. Communication with the operator control elements is therefore via 10Mbit or even 100Mbit Ethernet.

Within the station line, this is realized as follows: The higher-level CX1000 computer is connected with the Beckhoff ES2016 Ethernet switch with 16 RJ45 ports. The individual CX1000 controllers are connected to this system. For Thomas Ernst this was the first project involving an Ethernet network: “Initially, we used commercially available switches, but it quickly turned out that they simply couldn’t cope with our data quantities. With the new plug-and-play switches from Beckhoff, everything works flawlessly.”