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VME-Applications in Automation

Adapted from a report by Hermann Strass

Loewe Opta GmbH

Loewe Opta was founded by Dr. Siegmund and David Loewe together with two partners in Berlin during the depression of 1923. One year later they presented the first integrated circuit in the history of electronics. The triple tube (yes, there were electronic circuits before the age of the transistor) was co-developed with Manfred von Ardenne, a world-renowned scientist in the field of TV and electron microscope technology. Consequently Loewe also presented the first all-electronic TV receiver at the International Broadcast Exhibition 1931 in Berlin. In 1951 the 'Optaphon', the first tape recorder using cassettes rather than tape reels, was produced by Loewe. Loewe continues to be a medium-sized highly innovative corporation concentrating on 'consumer electronics', telecommunications and car electronics.

THE CHALLENGE

Key elements of the Loewe corporate spirit are: being innovative, creating consumer goods which are aesthetically pleasing and above all achieving the highest possible quality in their products. The company was committed to quality long before ISO 9000 standards became fashionable. This quality can only be maintained in mass production by 100% control of all relevant parameters at every stage of production. Data acquisition and control for this purpose is done in real-time using networked process control computers at the factory floor made by ISO 9001 qualified Kontron. Not surprisingly most of the electronic circuit boards for BMW (Bavarian Motor Works) cars are now produced and end-tested at the Loewe factory in Bavaria.

Flexibility at the highest quality level is required to produce TV sets for Panasonic of Japan in addition to Loewe designed TV sets. The design philosophies of these companies from such culturally different parts of the world are very significant. Loewe have streamlined their real-time measurement and control such that the production lines can run a mix of German and Japan designed TV sets on the same production line. This flexibility shortens time to market, reduces production cost and increases productivity.

Quality of the end product is the result of tight control of parameters at every stage of the production and the usage of a reliable, high quality, intelligent data acquisition and control system. For this purpose about 20 process-control computer systems are used in car electronics production and about 10 systems are used on the TV assembly line. These are VMEbus based real-time computer systems in 3U form-factor from Kontron. Loewe staff have designed and built all necessary adapter boards and interfaces which are connected into the Kontron systems using the PeriBus designed by Loewe. Some VMEbus systems from Kontron have been in use since 1988 at the Loewe factory very often work two shifts/day.

The company's name which is featured in this report is Loewe (which means lion German) Opta GmbH in Kronach, Bavaria. The application is about highly sophisticated data acquisition and real time control for automated production of TV sets and car electronics. This application may be described as individual mass production. In this application it is not a contradiction to speak about individual and mass production in the same sentence.

The team of the electronics measurement group at Loewe has designed and implemented this application in-house. They have used standard VMEsystems, built special cards and adapters where necessary and have programmed the whole application under the real-time, multi-tasking operating system OS-9 with their own staff.

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THE SOLUTION

Out of a large selection of subsystems a typical subsystem is described here. These VMEbus subsystems are equipped with rack-mounted systems and boards including real-time, multitasking operating system OS-9 from Kontron. Like typical VMEbus systems, they are equipped with a variety of interface cards into the process-control environment and they are connected to local sub-buses. The VMEbus was invented to allow an open system architecture for the co-operation of different cards and modules without problems. However, not all specific modules are available as commercially sold units.

In some cases custom-built Eurocards are needed in a system. Loewe engineers use boards which they designed and built to cope with the special requirements of their application. Therefore they now have a selection of board types, sub-systems and applicable software. This is a classical type of VMEbus system. Standard and purpose-built modules can be used in a single open system.

A typical 3U VMEsystem which is shipped pre-configured and tested by Kontron to Loewe might contain a VM20/VM30 (68020/68881) CPU card from Kontron, an Ethernet LAN card (VLAN running TCP/IP), a VIOC card to implement a local sub-bus (also using 3U Eurocards), a VSCSI controller for hard disk and floppy disk and some more I/O cards (serial, DA/AD, graphic, camera interface). The local sub-system contains more different I/O cards to connect to the real world such as data acquisition points, IEC-Bus and to the PeriBus which was designed by Loewe. The PeriBus may typically host relays cards, custom-built interface cards and AD/DA cards which are integrated by Loewe. Through the open software architecture of the OS-9 operating system, appropriate software drivers for each custom board have been developed easily

There are specific reasons why there is a hierarchy of buses with cards of the same or similar type on each level. The main reasons are the 3 'C's: cost, complexity and compactness. Not all boards need 24 bit addressing or a 16-bit wide data bus. So a lot of cabling, line drivers and circuit complexity can be eliminated. The saved board space may be used to host more interface circuits or lines. So with lower cost more interface points can be squeezed into smaller boxes.

The Multilevel Network: In systems of this type, a higher level control system is always required which implies networking. This is an advantage for systems from Kontron, since most of their CPU cards using 68302, 68360, 68020, 68030, 68040 and 68060 microprocessors are equipped with serial interfaces which can be used to implement various types of serial drivers for RS232/422 or RS485 based field buses like the PROFIBUS (DIN 19245) or special custom-built field buses.

Beyond that distance fiber optic links could be utilized. These field bus networks extend in length up to 300 meters. Software drivers for the operating systems such as OS-9 are available or were specially adapted. These sub-systems are networked together at the Loewe factory into three distinct networks around the MGL (Meßgerätelabor), Digital and Analog Servers. The computers and servers are all digital, however some subsystems are used to measure and set analog values in the tested devices, hence the name.

Programs are distributed, loaded and updated via the network just like normal data and values. Data analysis, i.e. for quality statistics may be done on DEC minicomputers on a higher level in the hierarchy of networks.

The high-precision Fixtures: A key element of the Loewe application are special built fixtures. Some designs were registered at the patent office to apply for patent protection. Let us briefly describe a fixture of the car electronics test section.

Circuit boards for car electronics deviate heavily from the familiar rectangular shape of Printed Circuit Boards (PCBs). They may have every imaginable odd shape. They are also stuffed with electronic, electro-mechanical and display elements of any size or height unlike the uniformly populated PCBs inside computer systems. PCBs in cars usually contain a number of adjustable potentiometers, adjustable inductors (coils) and other mechanically adjustable elements

For the purpose of measuring values within a given range and setting optimum working points the engineers at Loewe had to design fixtures containing tiny motors with screw-driver style operating elements to be lowered onto the devices for operation. Of course while doing this the drive shafts had to be operated such that the operating elements would exactly mate with the settable screw-like devices. Then during measurement and adjustment cycles these set points had to be set as their name implies. The adjustable screw-like elements must not be broken by turning beyond their end points (detents). To make matters worse all these measurements and adjustments must be done at temperature extremes of +80 and -40 degrees Centigrade as well as at a more normal temperature of 22 degrees Centigrade.

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To automate and accelerate this operation the PCBs are fed to the points of measurement and adjustment by means of belts or chains. Depending on size and complexity one or more PCBs are moved and tested in parallel. Despite their movement by means of belts and chains the PCBs have to be positioned within fractions of a Millimeter for proper operation. Because of the temperature cycling this has to be done within insulated temperature chambers. Temperature and moisture also complicates the problem of proper electrically contacting the measurement points on the PCBs which are located in three-dimensional space rather than on one plain. The 'bed-of-nails' in this case may contain spring-loaded nails which are really steel rods of irregular length with contact points which again must be positioned within fractions of a millimeter. All this has to be done in a repeatable automated sequence by the Kontron computers.

The modularity of each system in hardware and software allows fast and flexible adoption to new measurement types. Measurement values and other data are automatically transferred to sub-systems to print the reports which accompany each and every single tested PCB. We mentioned earlier that the high-level quality demanded by the applications requires 100% testing and documentation.

THE BENEFITS

As mentioned earlier there are three product groups manufactured at the Kronach factory. These are car electronics like air conditioning control, air control electronics, theft preventing and anti-skid electronics. Then there are consumer goods like TV sets. Finally there are telecommunications products like ISDN and analog devices. Obviously these products require different test equipment and procedures. Just imagine the complicated procedures to adjust a color TV tube for true color, minimum geometric distortions, temperature stability and low electromagnetic interference in contrast to temperature cycling and adjusting the operating points of an anti-skid PCB for a car. Your life may depend on proper operation of this device on a cold winter morning.

On the TV production line there may be a mix of TV sets of different design using TV tubes from 10 inch (25 cm) to 38 inches (95 cm) in diameter passing by the measurement computers. In such a highly complex environment you have to depend on reliable long-term stable VMEbus computer systems. Kontron computers have to have a high availability to allow the high production targets at Loewe. In the TV production line every day around 1200 TV sets leave the production. Even medium lot sizes of each type of product can be produced, there is flexible change between product types. Since the implementation of the automatic test systems from Kontron, the quality has been increased and is 100% documented for each individual product.

Whenever a new production has to be implemented or new test procedures are required, Loewe is able to build on the existing experience and system architecture and implement the new solution with a minimum of cost and time.

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