

EtherCAT controls DMX systems

Integrated lighting control at the Kuopio City Theater

In the fall of 2014, the City Theater in Kuopio, Finland reopened its doors after a two-year renovation and conversion period. It is the largest theater in eastern Finland that offers sophisticated and diverse entertainment to people in the region. Roughly eight to ten premieres and about 300 performances are held each year. To bring the theater's operations up-to-date technologically, the city's government decided to expand the 1960s' building and renew its technical equipment. The concept of a central lighting panel that controls the local DMX systems via an Embedded PC turned out to be the best available solution in terms of user-friendliness, flexibility and cost.

The theater's expansion and conversion, which was handled by ALA Architects in Helsinki, incorporates the existing building's materials – glass and white concrete panels – without ignoring the originality of the previous design. With its "folds", the facade of fiber-reinforced concrete reminds the observer of a giant origami. To connect the old and new parts, the architects attached a bridge-like section that runs from the old building's lobby to the new auditorium while forming a protective canopy. In its new incarnation, the facility now features a main stage with 464 seats, a studio theater with flexible seating and state-of-the-art stage technology, and expanded technical areas. Also upgraded were all technical systems from HVAC and electrical systems to stage technology and lighting controls.

Embedded PC integrates all lighting controls

In the past, the stage lighting in Kuopio's City Theater was controlled via a DMX-based panel, but the auditorium lights, the blue backstage lighting, the work lighting and the power outlets were all controlled separately. "As a result, we had to maintain multiple systems, which meant multiple suppliers, different programmers, many subcontractors and lots of work when systems had to be changed," says Juha Westman, Technical Director of the Kuopio City Theater.

"The decision to install PC-based control technology from Beckhoff was made in accordance with the end user's requirements," explains Aki Kalajainen, Manager Building Automation at Beckhoff. "The Kuopio City Theater wanted to have flexible control of its DMX environments independent of the lighting panel. It wanted to have lights that could be controlled outside of the show mode – for example during rehearsals or maintenance work. They also wanted to be able to easily integrate third-party systems. And the new system had to deliver a high level of flexibility with regard to system changes or expansions. All these requirements can be implemented much more easily and cost-effectively with an open, PC-based control solution than with conventional systems," says Aki Kalajainen.

For the local visualization and user interface, the City Theater in Kuopio uses a built-in CP6202 Panel PC, but the system can also be operated with a smartphone via web services.



The Beckhoff solution consists of a CX5010 Embedded PC as the central control unit, EL6851 and EL6851-0010 DMX master and slave terminals for controlling the local DMX environments, as well as various digital and analog I/Os and many KL2641 relays. All in all, roughly 550 terminals were installed. And with the BK1250 bus terminal, both EtherCAT and standard bus terminals could be mixed in the same bus station. The BK1250 recognizes the bus terminals and automatically assigns them on the EtherCAT system's process map. "For the local visualization and user interface we use the built-in CP6202 Panel PC, but the system can also be operated with a smartphone via web services," explains Jussi Piispanen of Beckhoff's Finnish subsidiary.

EtherCAT provides the backbone

The backbone of the new control platform is provided by EtherCAT, the high-performance, Ethernet-based fieldbus which was developed for industrial real-time communication. In connection with the EL6851 master terminal, it allows for the operation of an almost unlimited number of DMX environments simultaneously. With a cycle time of 10 ms and a single PLC task, 100 or more DMX environments can transmit the full protocol bandwidth of 512 channels. "Thanks to the option to integrate multiple DMX master or slave terminals into the system, the DMX environments can be distributed from the control panel to different switch cabinets and directly controlled via EtherCAT, which simplifies the DMX cabling and gives us more flexibility," explains Juha Westman.

"With the freely programmable TwinCAT automation software and the TwinCAT PLC DMX software library, we can create various lighting scenarios and assign them to buttons or graphical interface elements," adds Jussi Piispanen. "Even the relays are individually configurable as 'off relays', which switch off automatically at a specified time after the end of a performance."

In show mode, the input from the DMX slaves is copied to the outputs of the DMX master. Outside of show mode, when the control panel is not in use, such as during rehearsals or custodial work, certain control functions are available via buttons and the graphical interface. At these times, the Beckhoff platform controls all lighting and power control operations. The buttons for controlling the system in non-show mode are integrated via the digital KL2641 relay output terminal, which also controls the voltage of the DMX lights and the power outlets during shows. In show mode, these buttons can be locked to block unintended control commands. The manual operation option of this terminal has another benefit, for example during start-up phases when power is needed, but the controller has not yet completely powered up.

"The customer also wanted the ability to integrate additional components into the stage technology such as a fog machine, which exists in the DMX world. This requires a connection with the HVAC system so that the fog can be drawn in the right direction and the ventilation system adjusted accordingly. The serial KL6041 interface makes it possible. The communication between the central controller and the fog machine and the HVAC system runs over Modbus. This makes EtherCAT the powerful backbone, which covers all important



The City Theater in Kuopio, Finland. The building's old and new sections are connected by a kind of bridge that runs from the lobby in the old part along its facade to the auditorium in the new part while forming a protective canopy.



Based on a PC- and EtherCAT-based control platform, the City Theater in Kuopio accommodates flexible and independent control of the DMX environments, integrated light switches and buttons, and the ability to integrate third-party systems.

interfaces such as DMX, sACN, Modbus and more," explains Jussi Piispanen, before adding that "EtherCAT has several more advantages, such as flexible topologies and easy cabling, which provide significant cost benefits."

"For everyday theater operations, PC- and EtherCAT lighting control has a series of benefits with regard to new usage options, increased flexibility and more user-friendliness," adds Juha Westman.

Further information:

www.beckhoff.fi