

EtherCAT-based power measurement terminal enables high-precision current control



PC-based control system helps supply power to the Swedish railways

An important aspect of the power supply for railways is the control of fluctuations in the distribution network in the case of heavy or light rail traffic. IETV Elektrotechnik AB and the Swedish Transport Agency have developed a new digital control system for the power supply network using Beckhoff technology, which makes control times in the millisecond range possible.

IETV Elektrotechnik, based in Gällstad, Sweden, is an expert in supplying power to railways, hydroelectric power, wind power and industrial plants. The company has amassed extensive expertise during its 25-year history: "We can look back on a long tradition in the control of hydroelectric power plants and we have experience with synchronous machines that must be magnetized and monitored. With this as our background, we have also moved into railway applications," says Lars Christoffersson of IETV.

Relaunch of the converter substation controllers on the basis of PC control

The Swedish railways are supplied with power via 50 converter substations distributed across the country. The three-phase national grid with a frequency of 50 Hz is thereby converted into a single-phase railway power network with a frequency of $16\frac{2}{3}$ Hz. The converter substation in Frövi is used by the Swedish Transport Agency as a test station for refurbished systems. "Many of the systems needed to be completely rebuilt in recent years, while others were only partly renovated, for example, by installing a new drive or new switchgear," explains Lars Christoffersson. Each converter substation consists of a three-phase motor and a single-phase generator plus a transformer, which raises the voltage to 16,000 V. The converter substation is controlled and operated by a compact Beckhoff CP6607 built-in Panel with a 5.7-inch display.

Quick response times on the basis of EtherCAT

A synchronous drive is an AC drive, which is frequently used as a generator in power plants. The synchronous drive must be magnetized in order to generate a voltage and a field current controller is used to control it. "The field current controllers that we have used until now for controlling the power supply to the railway network were developed in close co-operation with the Swedish Transport Agency. However, many of the requirements had become outdated and referred exclusively to analog types of controllers. With our relaunch we wanted to digitize the controller and make it fit for the 21st Century," explains Lars Christoffersson and he adds: "We needed a controller with very fast response times. We are talking here about measurements in the AC mains network, which means reactions and control in the millisecond range. When we searched for an appropriate control platform, we found a suitable solution in the EtherCAT- and PC-based controls from Beckhoff."

Tomas Halvorsson from the Swedish Transport Agency and Lars Christoffersson from IETV Elektrotechnik belong to the team responsible for the new PC- and EtherCAT-based control system for the current converter.

"In principle, everything is now contained in the software, thanks to the digitization of the field current controller," explains Lars Christoffersson from IETV Elektrotechnik.



A total of 20 converter substations have now been modernized and converted to EtherCAT technology. The heart of such a station is formed by a Beckhoff Industrial PC (IPC) running TwinCAT automation software, which in this case is used with a Windows CE operating system. "In addition to the actual control software, TwinCAT offers many other features. TwinCAT Scope, a software oscilloscope, displays the fluctuations of the measured data graphically on the Panel PC, and is a very useful auxiliary tool for us," stresses Lars Christoffersson.

Power measurement terminals solve interface problem

"Using the Beckhoff power measurement terminal we solved the interface problem between high voltage values and control values, among other things," says Lars Christoffersson. An interface unit directly monitors the AC mains network and the railway power network without having to guide the signals through external converter boxes. The power measurement terminal monitors: current, voltage, power, energy, $\cos \varphi$, peak values of U, I and P, and frequencies. The information is transferred via an EK1100 EtherCAT Bus Coupler to the controller, where the data are available for further processing.

Integrated control platform saves components and space in the control cabinet

The advantage of the solution jointly developed by the IETV and the Swedish Transport Agency is that several functions can be combined on one hardware device. That saves components on one hand, and on the other engineering is simplified thanks to the common hardware and software platform. "Through the digitization of the field current controller, everything is now basically software-based. That offers us completely new possibilities: we are much more flexible than before, especially if we want to try something new or make a change," says Lars Christoffersson, explaining the advantages of the new control system: "With PC control we have a modular and expandable platform at our disposal. Perhaps the best thing about it is that the customer ends up with a high performance, compact solution."

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One of the mobile converter substations is subjected to a test.