Diesel electric propulsion systems on ships

Special safety concepts ensure reliability for a ship propulsion system. New functions are continuously being integrated in the ship’s control system. SAM Electronics and Bachmann have developed a concept for use with diesel electric drives.

The Royal Princess with diesel electric propulsion - controlled by the Bachmann M1 automation system (Photo: Bachmann)

THE MAIN COMPONENT OF A DIESEL electric drive are the diesel generator(s), frequency inverters, propulsion motor, propeller, and controller. Unlike conventional systems with two engines, which are each coupled directly to a propeller, with diesel electric propulsion systems the diesel engines drive generators. These all feed the same bus-bar from which both the drives as well as the other loads are supplied. This therefore makes the availability of a drive independent of an individual diesel engine since a reduced propulsion capacity is still provided in the event of a failure.

Considerable importance is placed on redundancy, particularly with the design of diesel electric propulsion systems for cruise liners. This redundancy is always based on a single fault event. Simultaneous multiple faults are not considered here. The propeller motors themselves are provided with two stator winding systems, each fed by a separate 6/3 phase, 12/6 pulse power section of a frequency inverter. Each converter section is supplied by an independent transformer with its own circuit-breaker.

Diesel electric drive control for a cruise liner: Redundant controller design with the M1 automation system (Photo: Bachmann)

The US company SAM Electronics is a international suppliers of ship automation solutions. Its offering includes systems for seagoing navigation and communication. The SAM propulsion system controller integrates the frequency inverters in the ship system. For this various remote I/O systems distributed over the entire ship are connected to the controller via serial bus systems. The frequency inverters are run in active standby mode. This means that the active controller collects the signals and also makes these available to the standby controller via Ethernet. If one controller fails, the standby system can then take over all control tasks seamlessly. If a single I/O system fails, decentralized arrangement of the I/Os also ensures that not all of the system information is lost. Appropriate processes are triggered depending on which I/O system is no longer available. If the serial bus system to the bridge fails, for example, the drive saves the last control lever setting and initiates an alarm: The failure of a steering console is indicated and control can be switched to another console, such as in the engine control room.

The implementation of these concepts and control tasks requires the use of a powerful controller. SAM Electronics therefore decided to use here the M1 automation system from Bachmann Electroni (Germany). “The scalable M1 system comes with the certificates required for ship applications and offers the right controller for every performance level, whilst still ensuring downward compatibility,” explains Hermann Knirsch, Drives and Special Systems Manager of Technology and Design at SAM Electronics.

One of the two propeller motors in the cruise liner Royal Princess (Photo: Bachmann)

All interfaces on board

The M1 controller covers all the interfaces required: CANopen, J1939, Modbus RTU / TCP, and Profinet come as standard. “The Modbus UDP protocol was specially implemented for us at short notice by Bachmann,” explains Hermann Knirsch. The controllers can also be expanded with CAN, Devicenet and Profinet communication modules as required.

“The cooperation thus enabled the joint and successful integration of a SAM controller library on the Bachmann system. All the tried and tested functions are thus still available. It offers SAM also the possibility of using other previously unused serial bus protocols such as Profibus, Profinet, Modbus/TCP etc. In this way, components such as the frequency inverters can be integrated even better,” says Verena Franzen, from Drives and Special Systems Technology and Design at SAM Electronics.

PLC editor

A PLC editor specially developed for complex applications enables the creation and visualization of complete functions. The status of signals is displayed in different colors. Faults can be localized and rectified. This graphical editor is used for maintaining the software of the old and the new systems. Partial applications from existing installations that are still implemented on the previous systems can thus be used again for new installations.

“Another benefit of Bachmann’s M1 system is the greater CPU performance and range of interfaces compared to the controllers we used previously,” Verena Franzen explains. This enables us to integrate completely new functions into the system. “For example, it will be possible in future to access the system directly from shore via satellite. This means that diagnostics can be carried out without having to send out a technician to the ship and that expert help can be given to the crew in the event of failures,” Verena Franzen describes the resulting benefits. “Software updates or controller adaptions for refurbishments can thus also be carried out at a later time from shore.”

Another new function provided is the ‘hot standby’ function. Due to the Ethernet communication between the two controllers of a drive, the standby controller can be activated in the event of a fault. The standby controller thus takes over as soon as the active controller fails, for example, due to a fault in the power supply: The drive is immediately activated and runs at the old speed value.