3 Profibus DP V1 for Actuators

Profibus DP V1 was chosen for the actuators (closed-loop and open-loop control actuators, and the rotary actuators at the low-voltage level) on account of the many advantages that can be leveraged by power plants. These include:

- Its proven track record in power plants,
- Its relatively reliable data throughput, which ensures real-time responses,
- Flexible bus topology for reducing wiring costs,
- Mixed redundancy, integration of repeaters for network expansion, and couplers for interfacing to other bus systems
- Cyclical/acyclical data traffic and reliable diagnostics functions.

Profibus DP V1 technology also allows intelligent field devices with enhanced functionality (SIPOS actuators and SIMOCODE switching devices) to be used and integrated in the central engineering system (ES680) for parameterization and diagnostic purposes.

The SIMATIC PDM with its routing function is used again here. The PDM supports end-to-end communication from the engineering station to the control system through to the individual field and switching devices in the low-voltage switchgear.

The redundancy concepts aim to implement suitable redundancy measures for controlling the field devices, starting at the two automation processors (AP) in the electronics room, to the two interface modules/master redundancy (TXP/IM308C), field bus wiring/line redundancy, through to the Profibus input board/slave redundancy of the field devices. This system redundancy is transparent for the application in question.

This consistent, redundant, control structure is mirrored in the switchgear configurations for the process-oriented generator sets, with the aim of providing maximum power unit availability (see Fig. 2).

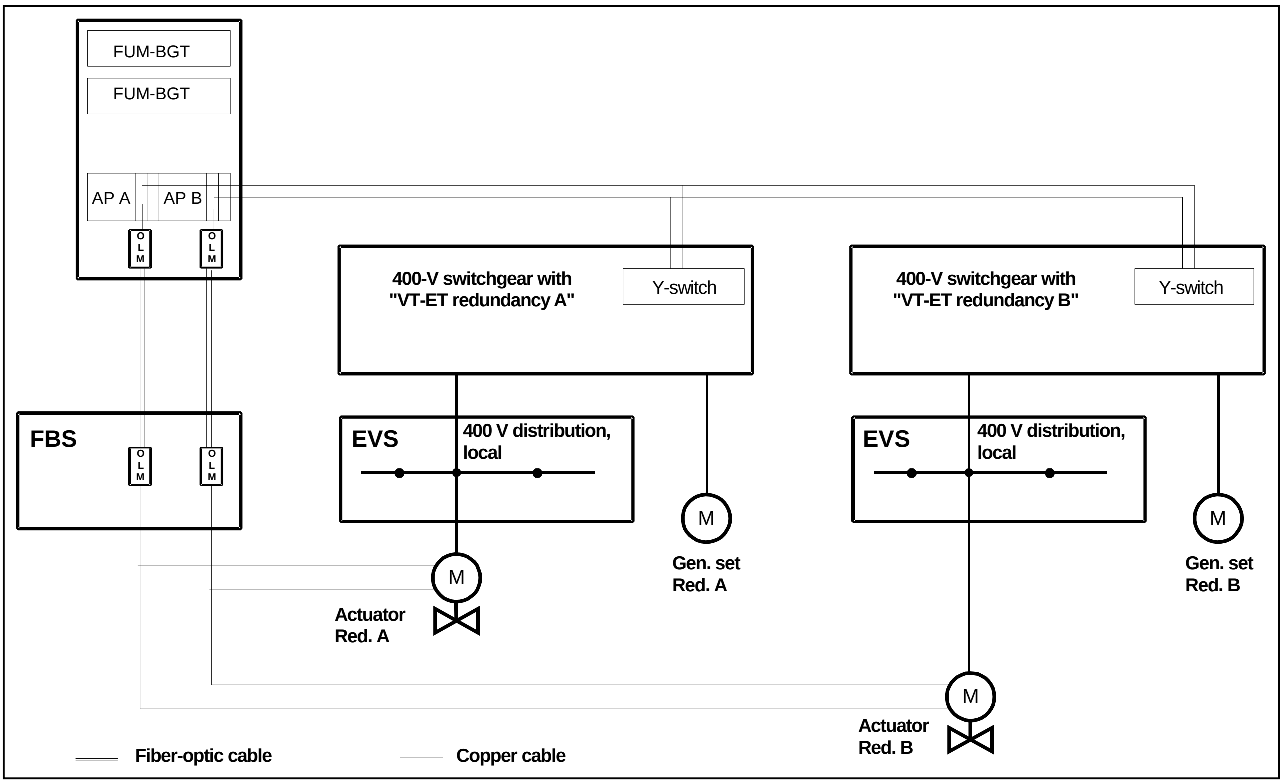

Fig. 2 Redundancy Concept

3.1 Open-Loop and Closed-Loop Control Actuators

Unit K uses intelligent actuators with redundant SIPOS 5 Flash Profitron Profibus connections. The SIPOS actuators are equipped with integrated power and communications electronics, which do away with the need for a controlled switchgear outgoing feeder and an actuator control module in the control system, and a power controller and control module for a closed-loop control actuator. These integrated communications and power electronics are installed separately from the electric actuator if ambient temperatures are particularly high or if the operating site is subject to severe vibration. Central actuator functions such as position detection and torque detection/cut-off are controlled by the integrated actuator electronics. The individual control level of the open-loop control actuator is handled as a function block in the automation processor, which sends the appropriate operating commands to the open-loop control actuator via the Profibus and evaluates the signals sent back. Open-loop control actuators are fitted with their own positioners with adaptive hysteresis, which are controlled by the process controller in the AP. "Outsourcing" this closed-loop control function to the local actuator reduces the signal traffic on the DP bus and ensures that the real-time-capable control response of the system is maintained. The frequency converters in the actuators support variable actuator speeds, end position soft starts and torque calculations. The actuator can also store three different torque/position curves, which are used for quality control purposes when the plant is being erected, and as a basis for a status-oriented maintenance concept.
The self-monitoring function for operating cycles, operating hours and torque-controlled cut-off in the intelligent actuator can trigger a maintenance request which, in conjunction with remote diagnosis via the PDM, supports a demand-oriented, preventive approach and opens up scope for reducing costs.

Other important actuator features include:

- Local operation
- Temperature measurement
- Analog position measurement
- Starting current suppression
- Direction of rotation does not need to be monitored
- No mechanical limit switches or torque limit switches
- Electronic torque limiting
- Electronic rating plate

3.1.1 Bus Concept

Open-loop and closed-loop control actuators are installed along common bus lines; mixed bus configurations are also possible by using repeaters. The selected transmission rate of 500 kbits/s restricts the copper bus segments to a length of 400 m. Repeaters can be used if greater distances have to covered. The number of electric actuators is limited to 64 stations by the TXP interface module IM308C. Two interface modules can be connected to one of the redundant APs (see Fig. 3).

Optical link modules (OLMs) are used in the bus wiring between the automation cabinets and field bus stations (FBS). An independent optical-fiber network is implemented here in line with the plant topology. In the FBS, which are installed as sub-distribution boards, the OLMs act as a transition point for the transmission medium from optical-fiber cables to Profibus copper cables. The copper bus branch lines can be arranged in a star configuration from the outgoing feeders of the OLMs. The bus ends are terminated with active bus terminators.

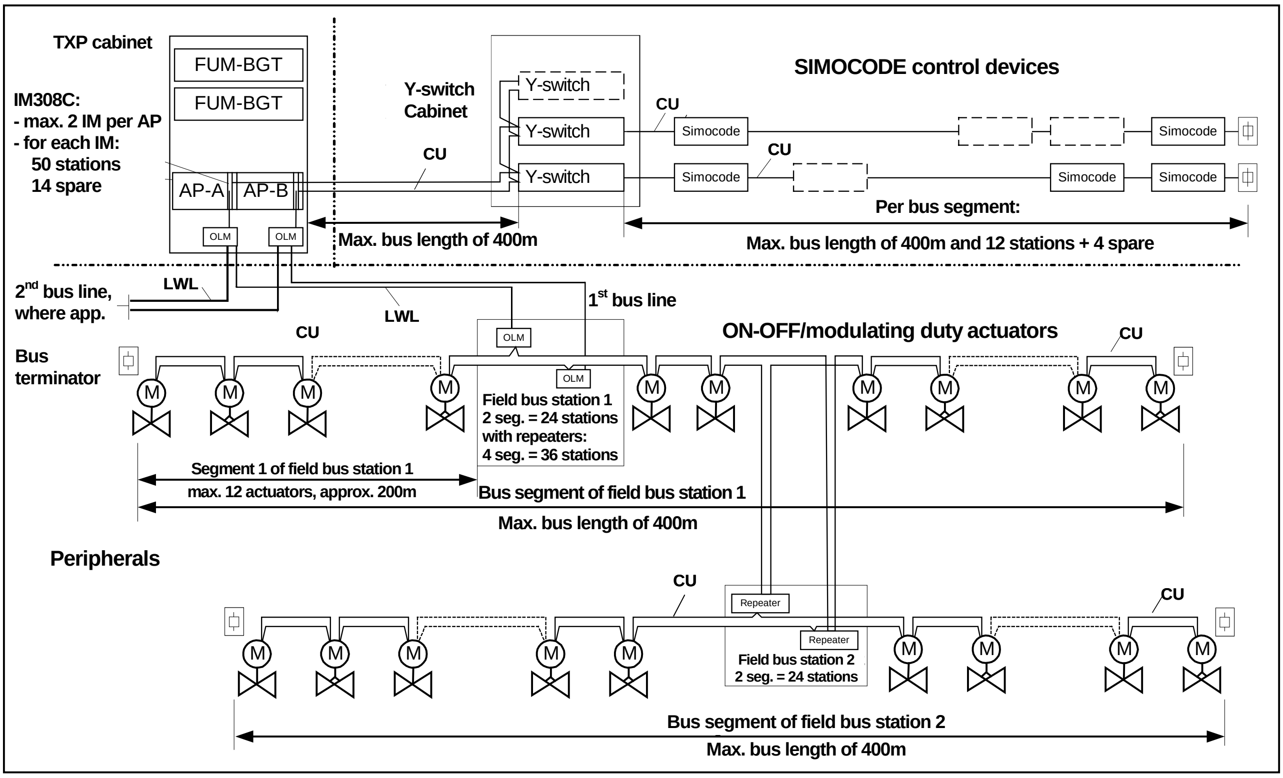

Fig. 3 Bus Concept

3.1.2 Power Supply Concept

The actuators are powered via distributed power distribution stations (PDS), which are mounted on a common rack with the FBS in the peripherals. These PDS are fed with a main incoming supply from the central 400-V switchgear stations and supply the actuators via individually-fused outgoing feeders either with 230 V AC (small actuators) or 400 V AC (larger actuators). This considerably reduces the wiring required. A "powerbus" is not used to supply the actuators due to the safety isolation problems involved. The power supply is monitored by the actuator electronics.

The 24-V DC supply voltage for the integrated power/communications electronics is derived from the actuator power supply. To ensure that bus communication with the control system is maintained if this internal 24-V supply fails, the actuators are provided with an additional external 24-V supply. Failures in individual actuators do not affect the availability of the power unit; bus switchovers in the auxiliaries, however, do. The brief interruption in communication that this would cause on the bus lines concerned could result in the power unit being shut down because no process checkback signals are received. The 24-V supply voltage is not buffered via energy-storage mechanisms in the actuator electronics due to the anticipated high level of maintenance involved.

The external 24-V supply voltage is formed via power supply units in the PDS, which are supplied by the 400-V UPS busbars, and is fed to the redundant diode-isolated incoming feeders of the FBS.

This redundant 24-V supply is fed to the actuators in a hybrid cable in order to reduce wiring. The shielded Profibus DP bus cable and a 24-V supply cable are integrated in the ECOFAST system hybrid cable. This redundant 24-V supply is connected physically as a ring feeder between the FBS and the actuators of the bus cable concerned, and forms a 24-V power bus.

The monitoring signals are sent from the FBS to the control system via binary contacts.

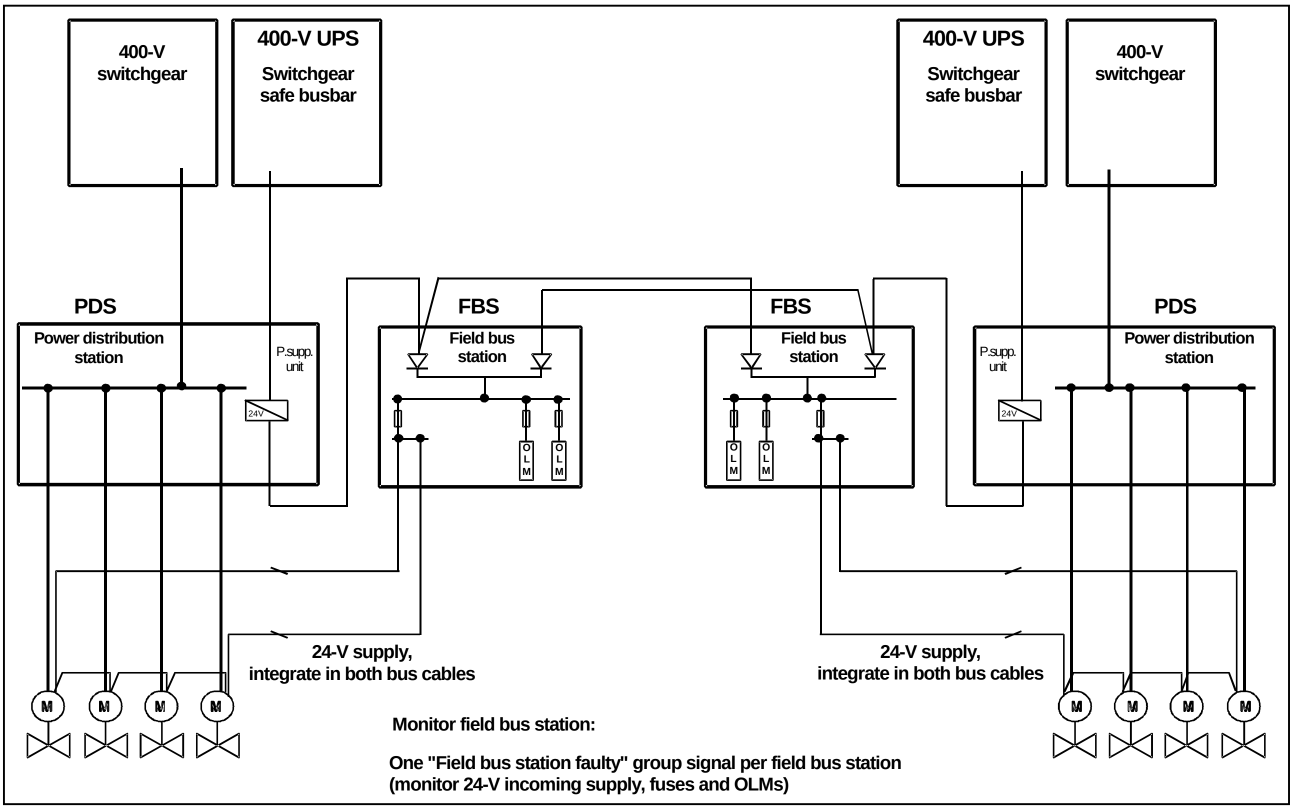

Fig. 4 Power Supply Concept

3.2 Continuous Actuators (Low-Voltage Level)

Intelligent SIMOCODE switching devices are used for the outgoing feeders in the SIVACON low-voltage switchgear station (MCC outgoing feeders), and communicate with the control system via a Profibus DP connection. The SIMOCODE switching devices are responsible for protecting and controlling the continuous actuators, and are fitted with a single Profibus DP port for communication purposes. The devices are also equipped with four binary inputs and outputs, which allow different switchgear feeder types to be implemented. The binary inputs can be used, for example, to activate the low-voltage function, which is then executed locally in the SIMOCODE switching device, and merely needs to be tracked in the control system to ensure that signaling is performed correctly.

The SIMOCODE switching devices are parameterized and serviced in the same way as the actuators via the standard operator control interface of the PDM and its routing function, right down to the individual switching devices in the switchgear. These activities are controlled from a workstation of the central ES680 engineering system of the control system. The parameters defined for the low-voltage switchgear are, therefore, an integral part of the database of the ES680 engineering system. Parameterization can also be carried out on the SIMOCODE operator display using a laptop.

Ranking between the control system and the switchgear is not possible because the actuators are assigned on field bus lines. Since the actuators were not allocated to the switchgear until a relatively late stage of the project, they had to be preassigned in the switchgear in accordance with the technological functional areas of the control system when the plant was being planned. Detailed assignments were then made later on.

One important feature of the SIMOCODE switching devices is that all actuators support a current measuring function, via which they are also monitored.

3.2.1 Bus Concept

The redundancy measures implemented in the bus concept for controlling the SIMOCODE switching devices are similar to those in the bus concept for the actuators (see Fig. 3). Starting from the redundant APs, redundant copper bus cables are routed to the switchgear via redundant IM308C interface modules (redundant bus masters). Since the SIMOCODE switching devices are linked by means of single Profibus connections, an interface is required to link the redundant buses to a single bus line. Y-switches, which are installed in separate cabinets in the switchgear stations, are used for this purpose. The Y-switches, which are supplied with redundant voltage, comprise two interface modules that terminate the two bus lines on the input side, and a Y-coupler which establishes the connection to a single bus line on the output side.

The bus lines here are configured in the same way as the actuator DP bus lines; in other words, two IM 308C interface modules per AP, and a maximum of 64 stations to one IM 308C. A maximum of 32 stations can be connected to the Y-coupler module on the output side. Only 50% (approx.) of this capacity is used in practice to ensure that sufficient reserves are available for retrofits.

3.2.2 Distributed Switchgear

Alongside the central switchgear stations of unit K, which are located in separate switchgear station buildings (SSB), the plant is also equipped with two distributed switchgear stations on two different levels of the boiler house. These distributed switchgear stations are housed in air-conditioned containers, and are responsible for controlling the 170 steam sootblowers and their auxiliary equipment (seal-air fans), which are used to clean the steam generators.

The significantly lower costs for the sootblower equipment wiring, which is controlled by the master control system, swayed the decision in favor of this distributed switchgear concept. The 24-V DC supply for the switchgear is generated on site in the distributed switchgear stations by means of power supply units.

The basic design of these distributed switchgear stations is in line with the Profibus DP concept of the central switchgear stations described in section 3.2.1. Fiber-optic cables and OLMs are used for the redundant field bus lines on account of the relatively large distances of 300 - 400 m between the switchgear station building and the distributed switchgear stations. The Y-switches establish the connection to the single Profibus DP, to which the SIMOCODE switching devices for controlling the sootblowers are connected.

Since the seal-air fans do not require a complex control system, AS-i modules (actuator-sensor interface) are used, which are connected to separate AS-i bus lines with a maximum of 31 stations/fan controllers. These AS-i bus lines are connected to the single Profibus lines by means of DP/AS-i links.