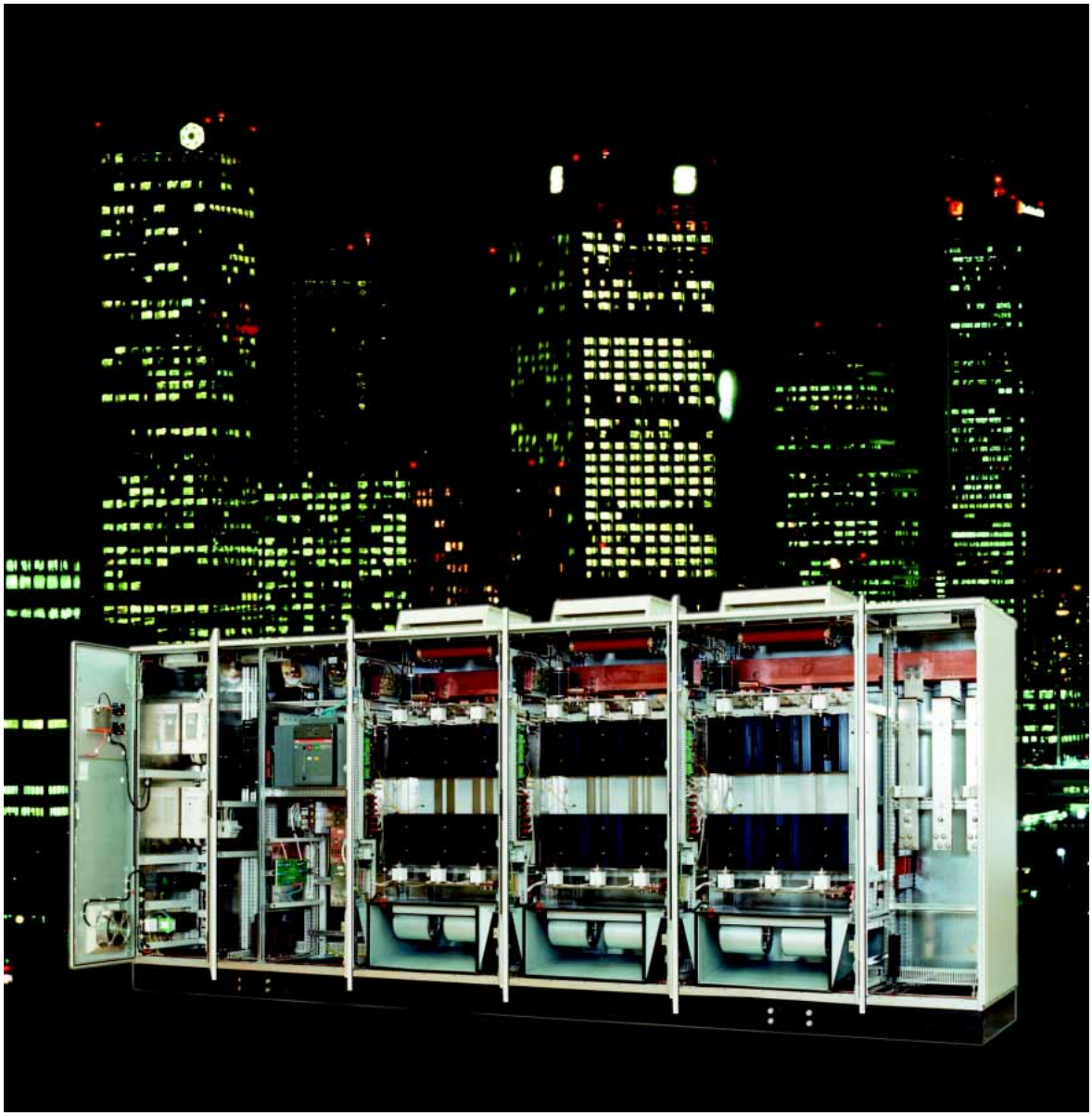
UNITROL® 5000

Excitation Systems for Medium and Large Synchronous Machines



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The UNITROL 5000 is the most powerful product in the ABB Switzerland UNITROL® series of excitation systems. The microprocessor-based voltage regulator uses the latest available technology. The development is based on more than 40 years experience with semiconductor voltage regulators and more than 15 years experience with microprocessor technology for this application.

Application areas

- **Static Excitation Systems** (SES) for 50 Hz, 60 Hz or 16 $^2/_3$ Hz power supply with field currents from 1000 A_{DC} to more than 10,000 A_{DC}
- **Automatic Voltage Regulating Systems** (AVR) for exciter machines with special functions, supply frequencies from 16 $^2/_3$ Hz to 400 Hz.

Regulator highlights

Additional regulator redundancy

- Dual-channel system with backup current regulator

Digital input processing

- Three-phase voltage measurement
- Three-phase current measurement
- Digital processing of the input values with a signal processor

Additional functions

- Software solutions only – without additional hardware

Additional inputs and outputs

- Easy to extend to the required number with ARCnet® devices
- Digital and analog

Event and error log

- With real-time stamp
- Remote interrogation possible.

Power section highlights

Power converter redundancy

- Up to a maximum of eight parallel power converters are possible
- Power converter redundancy is completely independent of the regulator configuration

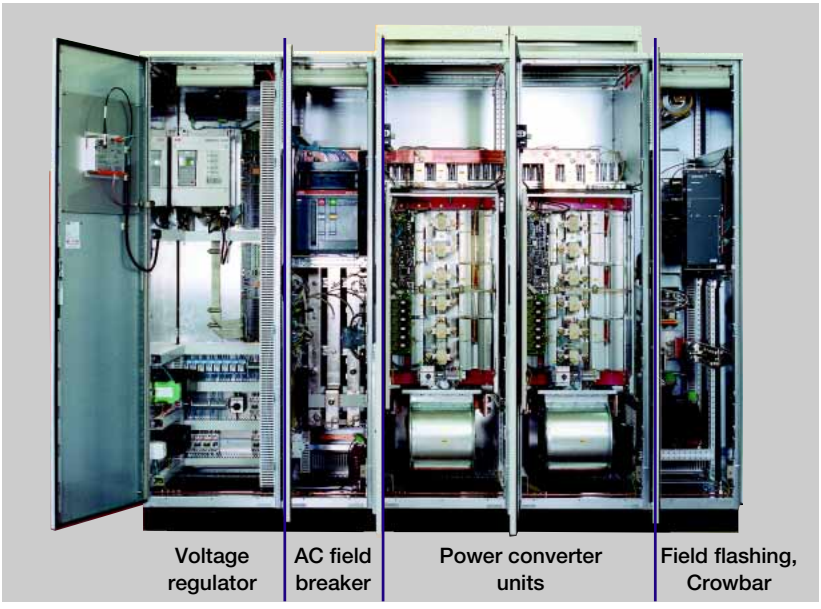
Intelligent power converter electronics

- Active equalization of the current between the power converters
- 4-quadrant operation (negative excitation current is possible)
- Thyristor current monitoring
- Fan control and monitoring
- Monitoring of fuses, power converter temperature and cooling-air flow
- Bridge current display.

Communication with the system

- The most frequently used protocols for higher level control systems are supported
- A second control panel in the control room is possible, up to a maximum distance of several 100 m
- Remote diagnostics by an ABB service office is available via Internet using the PC software “AVRview”.

Fig. 1:
The UNITROL 5000 has a modular structure of the function units



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The UNITROL 5000 is designed as a modular "building-block system". More than 80 % of all systems can be made from type-tested system components. This guarantees higher quality and makes shorter delivery times possible. The power section consists of one or more thyristor power converters, field breaker on the AC or DC side, the field flashing circuit and the solid state de-excitation system with Crowbar.

High availability due to the additional backup current regulator

To further increase the availability of the excitation system, in addition to the voltage regulator (AUTO) and the excitation current regulator (MAN), an **independent current regulator** (separate device with power supply, measurement and gate control circuits) can be used. Because of the follow-up control for all the inactive regulators, in the case of failure of the active regulator a smooth switch-over to a ready-to-operate regulator channel is guaranteed.

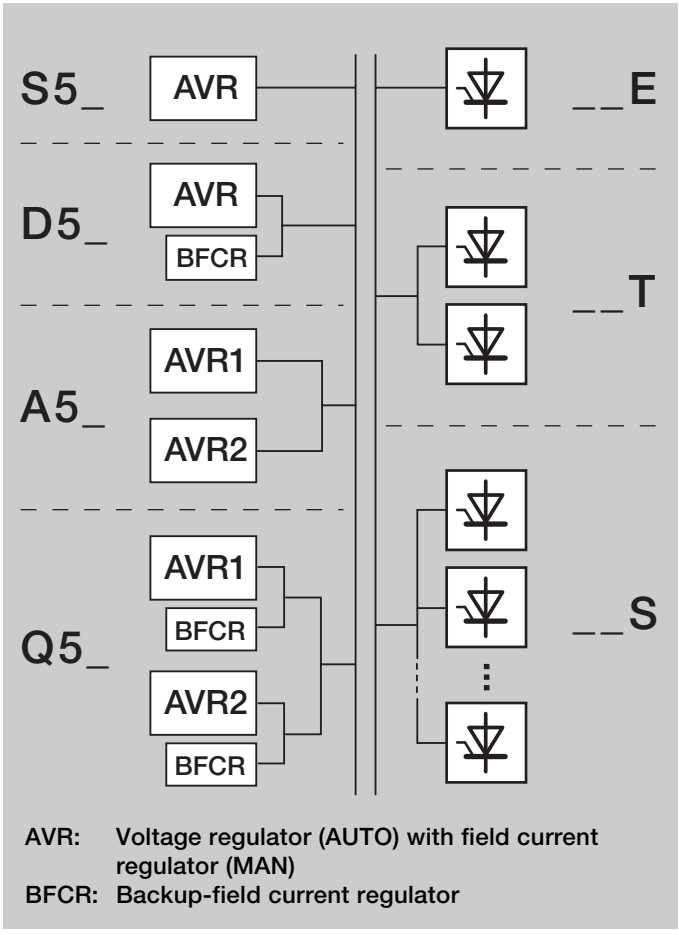

*Fig 2: The standard configurations of the voltage regulator section and power converter units can be combined at will, e.g. **S5T**, **D5E**, **A5S**, **Q5T***

Less wiring thanks to the internal ARCnet® field bus

The exchange of data within the system, e.g. between the voltage regulator, power components and interface devices takes place via the **serial ARCnet bus**.

Additional interfaces or control panels can be located and operated up to a distance of several 1000 m via an optical link.

Powerful and reliable power converters

Either compact power converters of the **DCS 500** series or type **UNL 13300** or **Verithyr** power converters are used for the UNITROL 5000. The type and the number of parallel power converters are based on the required field current, the ceiling voltage and the maximum duty-cycle required by the customer.

The following options are available:

- Natural or forced cooling
- Redundant fans
- Possibility to do maintenance work on one power converter during the operation of the system (with 5-pole isolator).

Equal distribution of the current between several power converters

For the first time for parallel power converters, a new ABB development offers **regulated distribution of the total current between the active units**. This can prevent the overloading of individual thyristor branches due to unsymmetrical current flows and significantly reduces the probability of a failure of the individual power converters (see Fig. 3 on page 5).

The well-structured software of the standard program already offers most of the regulation, protection and monitoring functions required for the secure operation of the excitation system and comprehensive event and data logging for diagnostics and service.

Functionality of the standard program

This comprises the following excitation specific functions:

Regulator functions

- Voltage regulator with PID filter (AUTO operating mode)
- Field current regulator with PI filter (MAN operating mode)
- Reactive load and/or active load droop/compensation
- Limiters for:
  - maximum and minimum field current
  - maximum stator current (lead / lag)
  - P/Q underexcitation
  - Volts-per-Hertz characteristic
- Follow-up control
  - CHANNEL 1 ↔ CHANNEL 2 (for dual automatic channel systems)
  - active CHANNEL ↔ BACKUP (for systems with backup regulator)
  - operating mode AUTO ↔ MAN
- Power factor / reactive load regulation
- MANUAL restrict
- Power system stabilizer (option)
  - conventional in accordance with IEEE - PSS2A
  - Adaptive power system stabilizer
  - Multiband power system stabilizer.

Protection and monitoring functions

- Field flashing time
- Overcurrent protection (instantaneous / inverse time)
- Volts-per-Hertz protection
- Loss of excitation protection
- Power converter temperature
- Rotor temperature
- Rotating diodes monitoring
- Thyristor conduction monitoring
- Power converter fuses monitoring
- Power converter fans monitoring
- Measuring circuit supervision.

Monitoring and protection functions are classified in three different action levels:

- Fault display only
- Switch-over to the second channel or to the backup regulator (if provided) or use of the available power converter redundancy
- Instantaneous excitation trip for protection purposes.

Control functions

All standard excitation sequences and interlocks are software-based with fixed pre-programmed function blocks.

They can be extended with freely programmable function blocks by the user.

Data recording

The UNITROL 5000 software has an **event recorder** (fault logger), that can record up to 100 events and alarms with real-time stamp. The logs are read and analyzed with the control panel or the CMT software.

Up to six measurement signals can be recorded in real-time with the **data recorder** (data logger). These can be displayed graphically in the CMT software trend window for diagnostic purposes.

Monitoring of the processor

Self check

After the power supply is switched on, the processor starts a self-check. The processor also monitors the various power supply voltages.

Program execution monitoring

The processor card has an internal watchdog function, which monitors the correct execution of the program.

The characteristics of the excitation system can be adapted by both extending the application program and with optional software functions, in order to optimally match the system to the customer's requirements.

Application function blocks

In addition to the standard software functions, further universally applicable function blocks of various kinds are available for the application program. These are tested application procedures such as input/output extensions, specific monitoring functions, etc.

Power System Stabilizer (PSS)

The purpose of the power system stabilizer is to improve the stability of the generator and the transmission system as a whole by using the excitation to damp load oscillations. The PSS operates by influencing the input of the voltage regulator – extremely effective with static excitation systems, but also effective for systems with rotating exciter.

ABB offers three different types of power system stabilizer:

PSS in accordance with IEEE

For the stabilizer in accordance with IEEE - PSS2A, fixed parameters take care of optimum damping with adjustable lead/lag filters. To determine these parameters ABB has calculation software that takes account of the generator and excitation system data, as well as the transformer and network reactances.

Adaptive power system stabilizer (APSS)

The adaptive power system stabilizer works with variable parameters that are set by continuous calculation of the working point and the current state of the power system. For the UNITROL 5000 no additional hardware is necessary – contrary to the UNITROL P system.

Multiband power system stabilizer (MBPSS)

Instead of a single lead/lag filter the MBPSS has three individually adjustable working bands, in order to ensure effective working over the complete frequency range of typically 0.05 ... 4.0 Hz. The three bands are designed to damp the electromechanical oscillations at low, medium and high frequencies.

Rotating diodes monitoring

With this addition, short circuits or open circuits in the branches of a rotating rectifier that is used in brushless systems are detected over a wide range of rotational speeds.

A software monitoring function calculates the harmonics of the excitation machine frequency from the excitation current signal. Depending on the amplitude in relation to the excitation current, it is possible to distinguish between a short circuit and an open circuit in the branch.

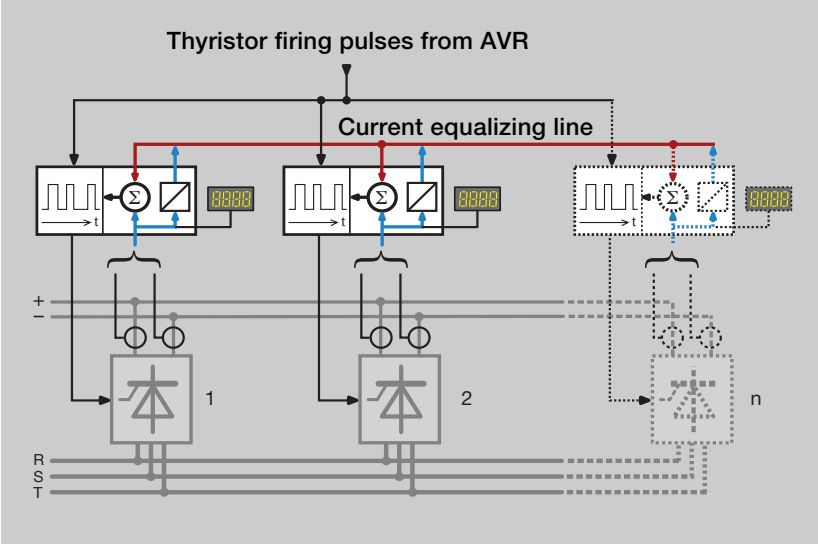

Fig. 3: Current equalization between several UNITROL 5000 power converters

Today, simple and user-friendly commissioning and operation are as important as the easy integration in higher hierarchical control systems. UNITROL 5000 offers several types of human machine interfaces, and also various bus couplers for higher hierarchical control systems.

Communication with the system

The service panel **SPA** is connected to the system via an RS485 interface. The four-line display shows system functions, system parameters, measured values, alarms etc. in clear text form. The excitation system can be controlled with the push-buttons.

The control panel **LCP** (optional for smaller excitation systems) can be used for local or remote control is connected via the ARCnet bus. The LCP is for the control of the system, the display of actual values and events.

Optical link for commissioning and service

The UNITROL 5000 system can be connected to a PC with the CMT software installed via an optical link. This ensures a fast and secure communication with the excitation system.

Integration in higher hierarchical control systems

Communication with higher hierarchical control systems is possible with the appropriate bus coupler that is connected to the DDCS interface (via an optical link).

The following standard protocols are supported for control and data transfer:

- **MODBUS**
- **MODBUS+**
- **Profibus**.

Remote diagnostics

If the excitation system is equipped with the optional remote diagnostics function, ABB service personnel can, with the customer's permission, access the system via the internet.

For further details, please refer to the last page of this brochure.

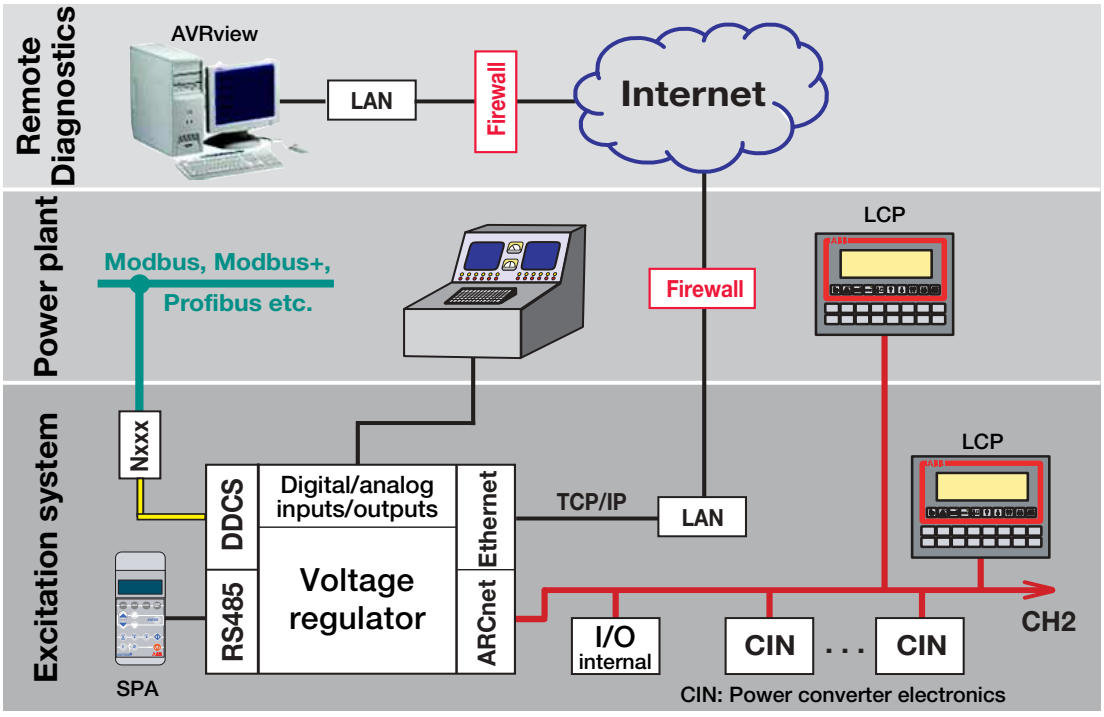

Fig. 4: Communication levels for the user friendly control and monitoring of the UNITROL 5000 system

Software Tools for Commissioning and Maintenance

The same software tools that were used for the UNITROL F system are used for the UNITROL 5000 system. These are the GAD tool and the CMT tool. Both have proved themselves as outstanding software tools for these applications.

Engineering software GAD

"Graphical Application Designer" (GAD) is a PC software tool for application programming. The tool has the following characteristics:

- Application programming for extending the standard functions
- Graphic editor to create and modify the program documentation
- User defined layout of the documents
- Possibility to create new documentation symbols.

The application programs created with the GAD software are loaded in the regulator module with the CMT.

Commissioning and Maintenance Tool (CMT)

With this software, modifications are made to the application program, the system functions are monitored and parameter values are changed. The program has a screen display, with which the system can be controlled and the status monitored. It has the following functions:

Trending display

- With this window (Fig. 5), up to six analog signals can be shown in real-time environment ("Trending")
- All the signals available in the system are selectable for this display
- User friendly menu for selecting the signals, including all parameters for scaling and offsets.

Application program display

- Display of the application program (Fig. 6), created with the GAD software
- Display of actual values of selected points in this display.

Parameter and signal display window

- Display and changing of parameters or signals in table form
- Each parameter or signal can be assigned to a parameter or signal group that can then be selected and processed as a group.

Other display windows

- Event log display, shows the last 100 events and alarms in chronological order ("Faults")
- Display of the data recorded ("DLog"), six channels, each with up to 1000 data points).

Fig. 5: Display of signal trends with CMT

Fig. 6 (below): Display of application programs and parameter values with CMT