UNITROL® 6000 X-power excitation systems
Proven performance solutions
Setting the standard

ABB is the world leading volume supplier of UNITROL® excitation systems for any type and size of nuclear power plant - known to provide a high return on investment since many years.

UNITROL® 6000 X-power is designed for large power applications and brings a new benchmark in flexibility, reliability and connectivity.

Tailor-made system
UNITROL® 6000 X-power uses well-proven functional modules. With single/double channel control configuration (additional back-up controller on request) and a wide selection of thyristor bridge modules, the system can be configured to meet all field data and availability requirements.

Main features
+ IEC 61131 application software programming with ABB Control Builder M
+ Fully compatible with ABB's Extended Automation System 800xA platform
+ Compliant with international and local standards
+ Fiber optic serial communication between the cubicles
+ Consequent electrical insulation and high EMC immunity
+ Easy detached installation of the control cubicle
+ Maximum safety for service personnel in case of online maintenance
+ 64 bit floating point CPU
+ No restrictions regarding data scaling and range

Selected applications
+ Nuclear power plant, field current Ifn >10,000 A
+ Underground hydro power plant, Ifn 4,500 A, redundant air to water heat exchanger system
+ Gas turbine power plant, MEGATROL package with Ifn 6,000 A and static frequency converter 15 MW for turbine starting
+ Coal-fired power plant, Ifn 3,500 A, power part in IP54 container, detached AVR cabinet with >150 m distance
+ Hydro power plant, Ifn 3,800 A, two DC field circuit breakers, one for DC backup excitation

Key benefits
+ Ultimate control performance keeps generator within safe limits
  High performance control platform AC 800PEC
+ Easy system operation, monitoring and maintenance
  User-friendly excitation control terminal
+ Short delivery time
  Uses well-proven prefabricated functional modules
+ Optimized contribution to network stability
  Integrated power system stabilizer (PSS) options
+ Offline tuning with closed loop real time generator simulator
  Offline system tuning and testing of severe system conditions (integrated or external option)
+ High control integration ability
  Prepared for IEC 61850
+ Efficient product life cycle management
  Extended life time of assets with minimum costs
+ Technical support always within your reach
  ABB's global excitation service network

ABB is the world leading volume supplier of UNITROL® excitation systems for any type and size of nuclear power plant - known to provide a high return on investment since many years.
UNITROL® 6000 X-power systems can be built with up to three control channels: two fully featured channels and one backup channel for emergency generator control. ABB delivers highly reliable excitation systems and carries out all the relevant certifications so that the systems comply not only with international rules, but also to the local standards too. The backup channel is a single communication, control and measurement (CCM) unit. Its separate hardware and different software guarantee utmost system availability. Each channel is able to control all modules of the redundant power converter. The modules are connected via their own converter control interface (CCI), which also provides diagnostic and maintenance functions including transient recorder. Converter signal interface (CSI) and gate driver interface (GDI) units are used to interface with internal and external analog and digital I/O signals. These units are 100 percent redundant, if required.
The UNITROL® 6000 X-power is engineered to meet the individual operational and environmental conditions as well as international and local standards. All systems undergo a 100 percent functional test before leaving the factory.

The shown UNITROL® 6000 X-power is designed for 1fm 2,882 A, with rated field voltage 585 V and 4,192 A ceiling current for 10 s.

Local excitation control terminal
- Basic service control panel
- Easy to use excitation control terminal

Control electronics
- 2 or 3 redundant control channels
- All devices easily accessible for testing and replacement during online operation

Field flashing
Enables voltage build-up in case of low residual generator voltage

The communication between control channel(s), power converter, and analog and digital I/O devices is done via fiber optic cables. It reduces electro-magnetic interference and allows an easy detached installation of the control cubicle. In case of online maintenance it provides maximum safety for service personnel.

Field suppression
Field breaker, discharge resistor and crowbar field overvoltage protection selected to meet all operational and possible fault conditions

DC output
DC cables / bus ducts enter from the bottom or top
**Excitation transformer**
A cast-coil dry type excitation transformer is recommended. It has proven its suitability in many installations and has advantages over other types of transformers.

**Cubicle protection degree**
IP31 as a standard, IP54 with integrated air to water heat exchangers upon request

**Converter control panel**
Provides actual values, converter current and temperature data, as well as LED status indication

**AC input**
Spacious cubicle to connect the AC cables/bus ducts entering from the bottom or top

**Power converter**
Fully controlled thyristor bridges

**Converter cooling fans**
Easily replaceable during operation of the system (2 redundant fans optional)

**Cooling air flow**
Forced air cooling with front air inlet and front or top air outlet
Control functions

The well-structured standard firmware includes all regulation, protection and monitoring functions required for the secure operation of the excitation systems. It can be, however, adapted to specific customer requirements by extending the number of I/O signals or adding optional software functions.

**Closed-loop control**
- Voltage regulator with PID filter (AUTO operating mode)
- Field current regulator with PI filter (MAN operating mode)
- Reactive and/or active current droop compensation
- Limiter circuits for
  - Maximum and minimum field current
  - Maximum stator current, dependent on machine cooling media temperature
  - P/Q under-excitation
  - Volts/Hertz
  - Manual restrict
  - Power factor/reactive load control
  - Power system stabilizer

**Data and event recording**
The internal event recorder function can handle and store up to 2,000 events, each provided with a real-time stamp. The data recorder contains a preconfigured part that can record 64 signals / 2,000 data points each, and a freely configurable part for 8 signals / 2,000 data points each.

The display and analysis of the recorded data is done by means of the excitation control terminal software.

If the excitation system is equipped with an excitation control terminal, the recorded data are downloaded into its memory to be available independently of the main controller.

**System time synchronization**
The system clock of all the controllers can be synchronized with a time source by SNTP (simple network time protocol) with an accuracy better than 1 ms.

The time signal can be sourced internally (from the excitation control terminal) or externally from the plant LAN (Ethernet).

With an optional receiver, GPS (global positioning system), DCF77 (Europe) or IREG-B (Asia, the USA) signals can be used as well.

**Protection and monitoring functions**
Monitoring and protection functions can be freely configured on three different action levels:
- Alarm signal only
- Changeover of redundant circuits
- Instantaneous excitation trip for protection purposes

**Major available functions**
- Overcurrent protection (instantaneous/inverse time)
- Volts/Hertz protection
- Loss of field protection
- Rotor temperature
- Thyristor conduction monitoring
- Actual value monitoring
- Field flashing time limit

**Sample of fast trending record for closed-loop AVR test**
Power system stabilizer (PSS)

For many years, ABB has been involved in the development and application of power system stabilizers. The PSS function improves the stability of the generator and the transmission system as a whole by using the excitation to damp power oscillations.

PSS types optionally available for UNITROL® 6000 X-power:
- According to IEEE standard 421.5-2005 PSS 2A / 2B
- According to IEEE standard 421.5-2005 PSS 4B
- Multiband PSS (on request)
- Adaptive PSS (APSS) developed by ABB in Switzerland

Synchronous machine transient simulator – real time (SMTS-RT 6000)

The new SMTS-RT 6000 simulates a generator/motor, its turbine/load and the grid. The simulator is connected to the excitation system for closed-loop test to analyze its stationary and transient behavior. A bidirectional fiber optic cable is the only connection needed to link the simulator to the UNITROL® 6000 X-power system. SMTS-RT 6000 can reduce the testing time of your machine, save costs and serve as a perfect training tool for maintenance and operation personnel. Commissioning time can be further reduced by tuning control parameter sets in advance, using the simulator and a UNITROL® 6000 X-power control device.

Grid codes

UNITROL® 6000 X-power control functionality is prepared to support any grid code. The extensive pre-set testing functions and powerful data recorders of the excitation control terminal (ECT) serve to test, tune and prove the performance of control, stabilizer and limiter functions. System frequency response can be analyzed quickly and accurately using the built-in white noise generator. This method allows minimum testing time and grid disturbance.

Data records are stored in the ECT’s dedicated memory and can be easily copied and integrated into electronic documents.

In combination with SMTS-RT 6000 it is possible to simulate the most critical plant or grid situations, which are typically impossible to test with a real generator.
Hardware components

The system is based on the AC 800PEC high performance processor family. It is an extension of ABB’s 800xA control platform, developed to meet the fast control requirements of power electronics.

Control
The AC 800PEC control system excels in very high processing speed, providing:

- Fast analog and digital process I/Os with a typical cycle time of 400 µs
- Fast closed-loop control and regular process logic implemented in a single controller
- Low-speed I/Os with a typical cycle time of 10 ms
- Very fast programmable logic for converter pulse control and optical communication with cycle time down to 25 ns

Power converter
The power converter contains one or more converter modules selected and connected in order to meet the system requirements with respect to duty cycle and availability. ABB has developed a range of power converters dedicated to static excitation system, for example D5, UNL 13300 and UNL 14300. The latter can be equipped with 3” or 4” thyristors.

Main features
- AC supply voltage up to 1,500 V
- High insulation level – HiPot test voltage up to 7.5 kV
- Redundant fans, replaceable during operation (option)
- Low noise level of cooling fans ≤70 dB(A)
- Active current balance control

Optional features of UNL 14300 power converter
- “Draw out” design
- Safe test position for online repair and function tests
- Removal or replacement of the power part with a module trolley

Converter modules D1 to D4 with integrated UC D240 CCM board

Measuring unit and main control channel of UNITROL® 6000 X-power

UNL 14300 power converter in draw out position
Communication features

The communication features of UNITROL® 6000 X-power systems ensure simple and user-friendly human machine interaction, whether it comes to system commissioning or integration into the plant control system.

Excitation control terminal (ECT)
The ECT is a user-friendly human machine interface, which enables operation, monitoring and maintenance of the system. It is a powerful industrial grade touch screen PC that runs independently of the system’s controller. Events and system data can be recorded over a long period of time. The LCD touch screen provides the operator with a range of selectable screens showing information on the actual status of the system in graphical and numerical form.

Integration into the plant control system
Ethernet and fieldbus protocols Modbus-RTU, Modbus-TCP and Profinet are the main choices for communication with the plant control system. Emergency control signals can be hardwired directly to the control board.

Remote services
Remote services and troubleshooting help to reduce costs associated with mean time to repair and service. UNITROL® 6000 X-power is prepared to support remote access. Thus the local maintenance staff can get all necessary support from ABB service specialists.
Software tools

Dedicated software tools simplify the everyday use of the system and allow additional programming if required.

Excitation control terminal (ECT) software

The ECT software is a valuable tool that enables commissioning, operation, monitoring and maintenance of the system. It can be either loaded on the excitation control terminal or installed on any PC operating under Windows.

The software has built-in user documentation in various languages that simplifies the troubleshooting procedure. Using the events screen the system operator can directly access the events description and get troubleshooting instructions. The feature supports many languages, such as English, German, French, Spanish, Portuguese, Russian and Chinese.

Control Builder M

Control Builder M is an IEC 61131 compliant tool to manage and customize AC 800PEC application software. It is part of ABB’s Extended Automation System 800xA and runs on Windows PC’s.

![ECT software, “events” screen showing troubleshooting instructions](image1)

![ECT software, “slow trending” screen](image2)
Service and support

For life cycle management or technical support, the worldwide network of UNITROL® specialists is at your service.

Installation and commissioning
The professionalism, extensive experience and multilingual skills of ABB’s engineers ensure a satisfactory installation and commissioning.

Training
ABB university offers standard and customized training courses for UNITROL® 6000 X-power excitation systems. On-site training options are also available. For detailed training programs, visit www.abb.com/abbuniversity.

Life cycle management
ABB’s excitation systems life cycle management model helps the customers to extend and maximize the life cycle of their assets at minimum costs. Depending on the product’s life cycle phase, the service specialists recommend necessary actions and approach the clients pro-actively to inform them on all maintenance, service and upgrade necessities.

Examples of life cycle services:
- Technical support for optimized reliability
- Remote services
- Preventive and corrective maintenance
- Upgrade and retrofit

For urgent technical assistance, please call the hotline:
+41 (0)844 845 845
(365 days / 24 hours)

or contact ABB by e-mail:
unitrol.supportline@ch.abb.com

ABB life cycle management model

<table>
<thead>
<tr>
<th>Active</th>
<th>Classic</th>
<th>Limited</th>
<th>Obsolete</th>
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<tbody>
<tr>
<td>UNITROL with complete life cycle services is available for purchase.</td>
<td>UNITROL with complete life cycle services is available for plant extensions.</td>
<td>Spare parts, maintenance and repair services are available as long as materials can be obtained.</td>
<td>ABB cannot guarantee availability of life cycle services for technical reasons or within reasonable cost.</td>
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Complete life cycle services are guaranteed for the active and classic phases. As soon as the system enters the limited phase, it is recommended to upgrade, retrofit or replace the equipment with the latest technology available in the active phase.
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