UNITROL® 1000

Compact and powerful automatic voltage regulators

- Stable and reliable control, even in the harshest environment
- Scalable product for machines that range from 100 kVA to 80 MVA
- Common tools and simulation models
- Grid code compliant with all required functionalities and services
UNITROL® 1000

The UNITROL® 1000 product family covers a wide range of applications for voltage regulation tasks of a synchronous generator or motor up to 80MVA. It sets a new benchmark for the global industry with respect to functionality, reliability and connectivity.

UNITROL® 1000 provides compact and reliable solutions. Various built-in control software functions, robust mechanical and electrical design enable a wide range of applications.

Main features
- Compact and robust AVR for excitation current up to 20 A;
- Separate communication and control processors;
- Wide range of built-in control software functions;
- Ethernet-based fieldbus interface;
- Wide range of power input voltage, for AC and DC input;
- Flexible and freely configurable measurements and inputs/outputs (I/Os).

Wide range of applications
- Land-based power plants based on diesel or gas engines, gas or steam turbines and hydro turbines;
- Marine: electrical propulsion and auxiliary supply;
- Traction: diesel electric locomotives;
- Wind: based on direct connected synchronous machines;
- Synchronous motors;
- Variable speed application.

ABB is the world leading volume supplier of high quality UNITROL® automatic voltage regulators (AVR) and static excitation systems (SES) that offers solutions for any type and size of power plant with high return on investment.
**Key benefits**

Stable and reliable control of your machine:
- Highly integrated and robust AVR for harsh industrial environment. Stable and accurate regulation even with highly disturbed voltages.

AVR for various applications:
- Fully configurable I/Os and measurement inputs and user-specific configurable fieldbus interface enable easy plant integration.

Easy operation, monitoring and maintenance of the system:
- Intuitive and user-friendly commissioning tool.

Full support for grid codes:
- Certified AVR according to German grid code including verified simulation models, capable of analyzing dynamic net faults (FRT);
- Built-in Power System Stabilizer (option), simulation models and grid code studies available.

Efficient product life cycle management:
- Extended life time of your assets with minimum costs.

Professional technical help always within your reach:
- ABB’s global excitation service network.

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**UNITROL® product portfolio**

<table>
<thead>
<tr>
<th>Product family</th>
<th>Static excitation system</th>
<th>Automatic voltage regulator, thyristor type</th>
<th>Automatic voltage regulator, IGBT type</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITROL® 6000 X-POWER</td>
<td></td>
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<tr>
<td>UNITROL® 6000 MEDIUM</td>
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<tr>
<td>UNITROL® 6000 LIGHT</td>
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<td></td>
</tr>
<tr>
<td>UNITROL® 1000</td>
<td>UNITROL® 1020</td>
<td>UNITROL® 1010</td>
<td>UNITROL® 1005</td>
</tr>
</tbody>
</table>

Excitation current $I_{exc} [\text{A}]$
UNITROL® 1010 and UNITROL® 1020

UNITROL® 1020 combines high performance control and power circuits with a simple mechanical design. The construction provides a platform for a broad range of applications, including those in highly demanding environmental conditions.

Furthermore, high levels of EMC immunity is achieved through separation of the power and measurement terminals from the I/O connectors.

Polymer housing
- Protects all live parts to prevent electric shocks.

USB port
- Connects the CMT1000 (commissioning and maintenance tool);
- Device configuration, event and data upload without any control supply voltage possible.

Indication LEDs
- Green: Power ON, blinking indicates software is running;
- Yellow: Excitation ON, blinking indicates Limiter is active;
- Red: Alarm, blinking indicates start up error.

Solid aluminium base plate
- Robust mechanical design allows use in high vibration applications.

Power and measurement terminals
- Specified up to 30 A continuous current and cable up to 4 mm² (AWG 24–10);
- Tension spring terminals for reliable connection;
- Easy access over test points.

Local human interface
- Intuitive local control "panel for indication of AVR status, active limiters and measurements;
- Local control can be taken over to change parameters.

Ethernet port
- Connects the CMT1000;
- Remote access over Modbus TCP.

Analog and digital inputs and outputs, serial fieldbus
- Tension spring connectors allow reliable wiring and fast replacement.
UNITROL® 1010 AND UNITROL® 1020

Local human-machine interface of the UNITROL® 1020 provides immediate data on AVR status.

UNITROL® 1010 is a compact device supporting a subset of UNITROL® 1020 and is designed for excitation currents up to 10 A nominal. It supports the same interfaces and has the same mechanical footprint as UNITROL® 1020.

Display
- Shows default operation mode, machine voltage and exciter current.

Softkey buttons
- Functionality according to the active menu.

Arrows
- Navigate through menu or set parameters.

UNITROL® 1005

UNITROL® 1005 is the most compact UNITROL® 1000 device and is designed for excitation currents up to 5 A nominal.

Ethernet port
- Connects the CMT1000;
- Remote access over Modbus TCP.

USB port
- Connects the CMT1000 (commissioning and maintenance tool).

Indication LEDs
- Operational indications.

Analog and digital inputs and outputs
- Tension spring terminals allows for reliable wiring.

Solid aluminium base plate
- Robust mechanical design allows for use in high vibration applications.

Power and measurement terminals
- Specified up to 30 A continuous current and cable up to 4 mm² (AWG 24–10);
- Tension spring terminals for reliable connection;
- Easy access over test points.
UNITROL® 1000 hardware types

<table>
<thead>
<tr>
<th>Hardware types overview</th>
<th>UNITROL® 1005</th>
<th>UNITROL® 1010</th>
<th>UNITROL® 1020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation current</td>
<td>5 A cont., 10 A ceiling @ 70 °C ambient temp.</td>
<td>10 A cont., 25 A ceiling @ 55 °C ambient temp.</td>
<td>20 A cont., 38 A ceiling @ 55 °C ambient temp.</td>
</tr>
<tr>
<td>Separate terminals for aux power supply</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Human interface</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Analog and digital I/Os</td>
<td>Digital: 4 outputs, 8 inputs Analog: 2 outputs</td>
<td>Digital: 8 I/Os, 4 inputs Analog: 3 inputs, 2 outputs</td>
<td>Digital: 8 I/Os, 4 inputs Analog: 3 inputs, 2 outputs</td>
</tr>
<tr>
<td>Interfaces</td>
<td>USB Ethernet</td>
<td>USB RS485/(CAN) Ethernet</td>
<td>USB RS485/(CAN) Ethernet</td>
</tr>
<tr>
<td>Mechanicals</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>Certifications</td>
<td>CE, DNV/GL, Traction</td>
<td>CE, cUL, DNV, GL, CCS, Traction</td>
<td>CE, cUL, DNV, GL, CCS, Traction</td>
</tr>
</tbody>
</table>

Order codes

UNITROL® 1005

<table>
<thead>
<tr>
<th>Material description</th>
<th>Order code</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITROL 1005-0011 ECO</td>
<td>3BHE043576R0011</td>
</tr>
<tr>
<td>UNITROL 1005-0012 LIGHT</td>
<td>3BHE043576R0012</td>
</tr>
</tbody>
</table>

UNITROL® 1010 and UNITROL® 1020

<table>
<thead>
<tr>
<th>Material description</th>
<th>Order code</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITROL 1010-0002 LIGHT</td>
<td>3BHE035301R0002</td>
</tr>
<tr>
<td>UNITROL 1010-0003 BASIC</td>
<td>3BHE035301R0003</td>
</tr>
<tr>
<td>UNITROL 1020-0003 BASIC</td>
<td>3BHE030579R0003</td>
</tr>
<tr>
<td>UNITROL 1020-0006 FULL</td>
<td>3BHE030579R0006</td>
</tr>
<tr>
<td>UNITROL 1020-0007 FULL + PSS</td>
<td>3BHE030579R0007</td>
</tr>
</tbody>
</table>
Connection diagrams

UNITROL® 1010 and UNITROL® 1020

UNITROL® 1005
## Technical data

<table>
<thead>
<tr>
<th>Power electronic input (AC/DC)</th>
<th>UNITROL® 1005</th>
<th>UNITROL® 1010</th>
<th>UNITROL® 1020</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC nominal input voltage</td>
<td>16 to 250 V_AC</td>
<td>0 to 250 V_AC</td>
<td>0 to 250 V_AC</td>
</tr>
<tr>
<td>Frequency</td>
<td>25 to 600 Hz</td>
<td>25 to 600 Hz</td>
<td>25 to 600 Hz</td>
</tr>
<tr>
<td>DC nominal input voltage</td>
<td>18 to 300 V_DC</td>
<td>0 to 300 V_DC</td>
<td>0 to 300 V_DC</td>
</tr>
<tr>
<td>Max. peak input voltage (non sinusoidal)</td>
<td>420 V_p</td>
<td>420 V_p</td>
<td>420 V_p</td>
</tr>
<tr>
<td>Min. required start voltage</td>
<td>6 V_AC/10 V_DC</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Auxiliary supply (controller) input

| AC nominal input voltage 3-phase | not supported | 9 to 250 V_AC | 9 to 250 V_AC |
| AC nominal input voltage 1-phase | not supported | 16 to 250 V_AC | 16 to 250 V_AC |
| Frequency                    | not supported | 40 to 600 Hz | 40 to 600 Hz |
| DC nominal input voltage      | not supported | 18 to 300 V_DC | 18 to 300 V_DC |
| Max. peak input voltage (non sinusoidal) | not supported | 420 V_p | 420 V_p |

### Excitation output

<table>
<thead>
<tr>
<th>Continuous current at 55 °C</th>
<th>8 A_DC</th>
<th>10 A_DC</th>
<th>15 A_DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overload current for 10 sec, 55 °C</td>
<td>16 A_DC</td>
<td>25 A_DC</td>
<td>38 A_DC</td>
</tr>
</tbody>
</table>

### Exciter current measurements

<table>
<thead>
<tr>
<th>Full range</th>
<th>0 to 25 A</th>
<th>0 to 38 A</th>
<th>0 to 38 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy/Resolution</td>
<td>&lt;1%/&lt;20 mA</td>
<td>&lt;1%/&lt;100 mA</td>
<td>&lt;1%/&lt;100 mA</td>
</tr>
</tbody>
</table>

### Machine and net measurements

<table>
<thead>
<tr>
<th>Machine voltage, 1-, 2- or 3-phase</th>
<th>up to 500 V_AC (1)</th>
<th>up to 500 V_AC</th>
<th>up to 500 V_AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine current, 1-phase</td>
<td>1 to 5 A_AC</td>
<td>1 to 5 A_AC</td>
<td>1 to 5 A_AC</td>
</tr>
<tr>
<td>Network voltage, 1-phase</td>
<td>up to 500 V_AC</td>
<td>up to 500 V_AC</td>
<td>up to 500 V_AC</td>
</tr>
<tr>
<td>Frequency range</td>
<td>10 to 150 Hz</td>
<td>10 to 150 Hz</td>
<td>10 to 150 Hz</td>
</tr>
<tr>
<td>Accuracy (-40° to 70 °C/at 25 °C)</td>
<td>± 1%/0.1%</td>
<td>± 1%/0.1%</td>
<td>± 1%/0.1%</td>
</tr>
</tbody>
</table>

### Voltage regulation

<table>
<thead>
<tr>
<th>AVR response time (3-phase/1-phase meas.)</th>
<th>&lt;20 ms/&lt;50 ms</th>
<th>&lt;20 ms/&lt;50 ms</th>
<th>&lt;20 ms/&lt;50 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWM limitation</td>
<td>0.5 to 99%</td>
<td>0.5 to 99%</td>
<td>0.5 to 99%</td>
</tr>
</tbody>
</table>

### Digital inputs and outputs

<table>
<thead>
<tr>
<th>Numbers of digital inputs/outputs</th>
<th>8/0/4</th>
<th>4/8/0</th>
<th>4/8/0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital IO voltage</td>
<td>24 V</td>
<td>24 V</td>
<td>24 V</td>
</tr>
</tbody>
</table>

### Analog inputs and outputs

<table>
<thead>
<tr>
<th>Number of analog inputs/outputs</th>
<th>2/0</th>
<th>3/2</th>
<th>3/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog IO range</td>
<td>±10 V/0...20 mA</td>
<td>±10 V</td>
<td>±10 V</td>
</tr>
</tbody>
</table>

### Communication interfaces

<table>
<thead>
<tr>
<th>Ethernet (cable length &lt;100 m)</th>
<th>10/100 MBit/s</th>
<th>10/100 MBit/s</th>
<th>10/100 MBit/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB version (cable length &lt;3 m)</td>
<td>1.0; 1.1; 2.0</td>
<td>1.0; 1.1; 2.0</td>
<td>1.0; 1.1; 2.0</td>
</tr>
<tr>
<td>CAN (cable length &lt;3 m)</td>
<td>not supported</td>
<td>Only for connections between UNITROL® 1000 devices</td>
<td>Only for connections between UNITROL® 1000 devices</td>
</tr>
</tbody>
</table>

---

(1) 3-phase power supply and external 1 mF capacitor required to operate UNITROL® 1020 between 15 A and 20 A nominal excitation current.

(2) UNITROL® 1010 and UNITROL® 1020, machine voltage measurement above 250 VAC requires connection of machine star point to earth (PE).
Mechanical dimensions

UNITROL® 1020

Dimensions, L×W 302×170 mm
Height 111.4 mm
Weight 3.8 kg

UNITROL® 1010

Dimensions, L×W 302×170 mm
Height 85 mm
Weight 2.8 kg

UNITROL® 1005

Dimensions, L×W 230×161 mm
Height 72 mm
Weight 1.5 kg

Remark:
The dimensions are given in millimeter (mm)
Control Software

Eco:
The ECO version covers essential functionality for cost sensitive applications.

Light:
The light version adds to ECO standard functions as rotating diode monitoring and remote control via modbus. Furthermore, a simplified data logger called history logger allows the user to track the last two hours of operation for analyzing.

Basic:
The BASIC version is the ideal solution for applications with multiple machine operating on the same busbar. Accurate reactive load sharing via serial communication (VDC) and fast automatic synchronization are the key functionalities. Furthermore, a dual-channel functionality and motor start sequence functionality are supported.

Full:
Complex and demanding projects often ask for transient recorders and plant clock synchronized data logger function.

The FULL version has the capacity to meet these requirements.

Power System Stabilizer (PSS)
PSS can be an option to provide standard IEEE 421.5-2005 2A/2B/2C function. The PSS provision is nowadays included in most grid codes. The PSS is used for effective damping of power oscillations caused by the physical power grid.

Software upgrades can be ordered and easily enabled by password over the CMT1000, even while the unit is in operation.

Common software and tool for the complete UNITROL® 1000 product portfolio:
All UNITROL® 1000 products are based on the same target software source code, therefore equal performance can be seen with UNITROL® 1010/20 as well as with UNITROL® 1005. The same simulation models can be used for the entire UNITROL® 1000 product family, making UNITROL® 1000 products suitable for very demanding grid code applications.

### UNITROL® 1000 software functions overview

<table>
<thead>
<tr>
<th>Software functions</th>
<th>UNITROL® 1005</th>
<th>UNITROL® 1010</th>
<th>UNITROL® 1020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVR/FCR/PF/VAR</td>
<td>ECO</td>
<td>LIGHT</td>
<td>LIGHT</td>
</tr>
<tr>
<td>Limiters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection/Monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage matching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LIGHT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History logger</td>
<td></td>
<td>LIGHT</td>
<td>LIGHT</td>
</tr>
<tr>
<td>Modbus TCP with operator select</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotating diode monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BASIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive load sharing via RS485 (VDC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual channel</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Auto-synchronization (SYNC), 60/50/16.7 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor start support (only for UNITROL® 1020)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>FULL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event logger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data logger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real-time clock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time synchronization by SNTP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OPTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power System Stabilizer (PSS)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Commissioning and maintenance tool CMT1000

CMT1000 is a commissioning and maintenance tool for the UNITROL® 1000 product family. The tool is used to setup all parameters and tune the PID to guarantee stable operation. The CMT1000 software allows an extensive supervision of the system, which helps the user to identify and locate problems during on-site commissioning.

The CMT1000 is connected to the UNITROL® 1000 via USB or Ethernet port, where Ethernet connection allows remote access over 100 meters.

1. Main window
   - Indication of access mode and device information;
   - Change of parameter is only possible in CONTROL access mode;
   - LED symbol indicates that all parameters are stored on non-volatile memory.

2. Setpoint adjust window
   - Overview of all control modes, alarms, generator and active limiters status;
   - Set point adjustment and application of steps for tuning of the PID.

3. Oscilloscope
   - 6 signals can be selected out of 21 recorded signals;
   - The time resolution is 50 ms;
   - Files can be saved to PC for further investigation.

4. Measurement
   - All measurements on one screen.
Grid code compliance functionality

Specific AVR functionalities to support grid stability.

Super imposed PF/VAR controller with Low Voltage FRT and Over voltage FRT support function:
UNITROL® 1000 device provide as standard function super imposed PF/VAR controller, which allow to separate a dynamic control for minimum PQ Limiter and a slow control for PF/VAR set point. The control structure will support network dips by stabilizing the network. Furthermore dynamic detection of FRT will allow to regulate set point dynamically to avoid heavy reactive power overshoot to the network.

IEEE Power System Stabilizer
UNITROL® 1010 and UNITROL® 1020 provides Power System Stabilizer (PSS) as SW Option. PSS is implemented according to IEEE Std. 421.5 PSS 2A/2B/2C. The objective of PSS SW option is to increase the generator exciter’s contribution to improving the stability of the highest possible operation range of the generator.

UNITROL® 1000 provides special feature to support Application with reciprocating engine as:
- Cylinder firing frequency filter to damp natural oscillations of the engine;
- Common voltage step along multiple machines to test performance of a complete power plant, where multiple machines are connected via one common step up transformer;
- Integrated injection signal generator to run frequency response analysis without any additional equipment.

Example of fault ride-through defined grid code. ABB offers grid code compliant studies in order to prove stability under all circumstances.

In addition, ABB provides several levels of service:
- Calculation of PSS parameter;
- Simulations of reference step responses;
- Stability simulations for various different network conditions;
- On-site tuning service.

Remark:
Settings of PID are interlinked to AUTO-PID (Voltage regulator)
UST_PWM is added to the AVR output
ABB’s UNITROL® 1000 excitation products are certified according to German grid codes (VDEAR-N 4110 and VDE-AR-N 4120)

ABB successfully passed the most difficult certification process based on hardware in the loop setup and received a component certificate for its UNITROL® 1000 devices. Test procedure covered 3-phase and 2-phase low- and high-voltage fault ride-through (FRT). UNITROL® 1000 devices demonstrated excellent performance in supporting the network during and after fault conditions. The component certificate includes accurate Power Factory model, where simulation results match the measurements. The certification process required separate measurement by an external measurement company and verification of simulation results by a certification company.

UNITROL® 1000 user benefits include:
• Controller fulfills latest German grid code requirements;
• No re-certification of PGU (power generating unit) required in case of AVR firmware update/exchange with another certified ABB device;
• State-of-the-art simulation model available, accuracy requirements according to German grid code are met;
• Simple integration of the AVR simulation model in a generator simulation model.

UNITROL® 1000 systems

ABB provides over 100 years of experience in building project specific engineered systems for any applications. ABB offers various different systems depending on the need of the customer.

In addition ABB can offer full engineered solutions for:
• Single channels systems;
• Dual channel systems;
• Mounting on a plate or in a cubicle.

Systems include protection breaker and exciter field breaker. They are fully tested in the ABB factory and AVR setting can be ordered preset. Ask our experts for more information on:
• Multiple power input sources;
• Synchronization of your machine;
• I/O extension with external programmable logic controller over field bus.
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 offers standard and customized training courses for UNITROL® excitation systems. On-site training options are also available. For more details, contact your service representative today!

e-Learning
With the UNITROL® 1000 interactive e-learning program you decide where and when you learn. The program covers general excitation knowledge as well as detailed product handling know-how.

UNITROL® 1000 global support organization
A team of qualified engineers located in different ABB organizations worldwide are ready to support you with your most challenging enquiries and application requirements.

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;
- Spare parts delivery;
- Preventive and corrective maintenance;
- Upgrade and modernization.
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