UNITROL® Excitation for Motors

Choose the optimum solution from a wide range of products
Requirements of excitation for synchronous motors

Synchronous motors are used in many industries such as paper, metal, cement, sugar, oil and gas for driving pumps, cylinders, ventilators, mills, etc.

In all of these applications, stable network operation requires the fitting of automatic regulators. In addition to the original task of controlling the voltage at the motor terminals, UNITROL motor excitation can perform many other tasks:

- Limiting rotor and stator current
- Limitations to prevent falling out of synchronism
- \( \cos \varphi \) or reactive power control
- Start-up sequences
- Stop sequences
- Protection and monitoring functions
- Integrated manual channel for maintenance and commissioning purposes

Possible expansions:

- Electronics and rectifier redundancy
- Communication to higher-level control systems

Additional options:

- Calculation and supply of the auxiliary transformer and the starting resistor

Possibilities for starting up synchronous motors

An important phase in the operation of a synchronous motor is the start-up. In practice, there are many different types, for example:

- Start-up with a pony-motor
- Run-up with a frequency converter
- Hard asynchronous start-up (stator is connected directly to the network)
- Soft asynchronous start-up with start-up transformer or limiter choke on the stator side

All of these start-up methods come in many variations.

UNITROL motor excitations support any chosen start-up method with suitable solutions.
The right solution for any synchronous motor

Wide range of devices to cover all needs

The UNITROL® devices and systems which have been tried thousands of times with generators of all sizes are also ideally suitable for motor applications. As well as standardized solutions, for OEM customers for example, we also offer customer-specific solutions.

- For simpler systems with low output power, the compact voltage regulator **UNITROL 1000** is the right solution. It can be supplied as an individual unit or mounted together with peripheral components on an installation plate.

- A **UNITROL F** is ideally suitable for more complex applications and/or higher power requirements. These systems are supplied either as an installation unit on a frame or as a complete cabinet.

<table>
<thead>
<tr>
<th>Function</th>
<th>UNITROL 1000</th>
<th>UNITROL F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic voltage regulator with adjustable PID transfer function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limiting regulators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maximum excitation current (multi-stage)</td>
<td></td>
<td></td>
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<tr>
<td>• Maximum stator current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Minimum excitation</td>
<td></td>
<td></td>
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<tr>
<td>cos φ / reactive power control</td>
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<td></td>
</tr>
<tr>
<td>Digital set points with remote setting option</td>
<td></td>
<td></td>
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<tr>
<td>Smooth switch-over between all operating modes</td>
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<td></td>
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<tr>
<td>Redundancy of regulator and power unit (2 x 100 %)</td>
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<tr>
<td>Programmable start sequence</td>
<td></td>
<td></td>
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<tr>
<td>Slip monitoring and release of excitation at correct time (static excitation)</td>
<td></td>
<td></td>
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<tr>
<td>Protection functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Diode monitoring (brushless excitation)</td>
<td></td>
<td></td>
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<tr>
<td>• Loss of excitation monitoring</td>
<td></td>
<td></td>
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<tr>
<td>• Overcurrent protection (excitation current)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Overvoltage/undervoltage monitoring of supply voltages</td>
<td></td>
<td></td>
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<tr>
<td>• Start-up time monitoring</td>
<td></td>
<td></td>
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<tr>
<td>• P.T. monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rotor earth fault monitoring (static excitation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rotor temperature measurement (static excitation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial interface to higher-level control system (Option)</td>
<td></td>
<td></td>
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<tr>
<td>Configuration using PC software</td>
<td></td>
<td></td>
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<tr>
<td>Event logger with time stamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-channel data logger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input and output values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital inputs</td>
<td>typ. 4, max. 14</td>
<td>max. 32</td>
</tr>
<tr>
<td>Digital outputs</td>
<td>max. 4</td>
<td>max. 32</td>
</tr>
<tr>
<td>Analog inputs</td>
<td>max. 3</td>
<td>max. 4</td>
</tr>
<tr>
<td>Analog outputs</td>
<td>2</td>
<td>max. 4</td>
</tr>
<tr>
<td>Input voltage</td>
<td>max. 250 VAC (single- or 3-phase)</td>
<td>max. 500 VAC (3-phase)</td>
</tr>
<tr>
<td></td>
<td>max. 300 Vdc</td>
<td>max. 300 Vdc</td>
</tr>
<tr>
<td>Maximum output current (excitation current)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• With exciter machine (AC supply f_s ≥ 50/60 Hz or DC supply)</td>
<td>15 A_DC</td>
<td>40 A_DC</td>
</tr>
<tr>
<td>• Static excitation (AC supply f_s = 50/60 Hz)</td>
<td>780 A_DC</td>
<td></td>
</tr>
</tbody>
</table>

Both systems are suitable for new installations and as replacements for existing voltage regulators and static excitations.

The most important differences between UNITROL 1000 and UNITROL F in terms of functionality and input and output parameters are shown in the following table.
UNITROL® 1000 – Low output power, high functionality

Compact, economical devices and systems

The mechanical structure of the UNITROL 1000 unit is extremely compact and robust (see Fig. 4 below).

Despite the high functionality of the UNITROL 1000 unit, peripheral components such as circuit breakers, relays etc. are still required for a voltage regulator system. Therefore, we also supply a ready-wired and tested installation plate with all the necessary components which is installed in the vicinity of the motor, e.g. in an existing cabinet. We can also supply the installation plate with suitable cabinet. A configuration tool is available to Internet users to define the installation plate and the components which are to be provided.

The adjustment of the device is usually carried out using the PC software “CMT 1000”. However, it is also possible to set all parameters directly on the device without additional aids.

Features of the UNITROL 1000

- Microprocessor-based digital voltage regulator with \( \cos \phi \) or reactive power regulator
- Various limiting regulators prevent overloading of the motor
- Integrated monitoring functions protect the motor and excitation
- Commissioning and maintenance software (CMT 1000) for simple commissioning, maintenance and optimization
- Interactive configuration of the system via the Internet (www.abb.com/unitrol under “UNITROL 1000 Configurator”)
- Interactive training via the Internet (E-Learning). Take a look at the demo version at www.abb.com/unitrol “UNITROL 1000 Web-based training”

Fig. 3: Installation plate with peripheral components, built into small switchgear cabinet

Fig. 4: Simple installation with four screws, simple operation using push-button and LCD display

Fig. 5: Simple optimization of the machine-voltage-dependent P/Q limiter using “CMT 1000”
Proven and therefore quickly deliverable solutions

With a standardized series of UNITROL F excitation systems, ABB offer a wide number of solutions for the excitation of synchronous motors. Technical details of the six available types can be found on the next page. Various delivery options are also shown.

The excitation system is a single-channel system with digital regulator, fully-controlled thyristor bridge and de-excitation circuit with rotor overvoltage protection. The regulator contains motor-specific software with programmable start sequence and cos \( \phi \) or reactive power regulation, depending on the start method, operating mode and motor load.

UNITROL F systems are normally supplied fully wired-up and tested and built into a cabinet. Alternatively, systems with lower power are also available mounted on a frame.

### Features of UNITROL F system

- Microprocessor-based digital voltage regulator with cos \( \phi \) or reactive power regulator
- Various limiting regulators prevent overloading of the motor
- Integrated monitoring and protective functions protect the motor and excitation
- Simple operation of the system (including altering parameters and programs) via the local control panel
- Integrated data logger with 6 channels, each with 1000 values (see example on last page)
- Integrated event logger with time stamp for 99 events
- “CMT 5000” commissioning and maintenance software for simple commissioning, maintenance and optimization (option)
- Remote diagnosis via modem (option with additional hardware)
## UNITROL® F Technical data and options

### Choose your optimum system

<table>
<thead>
<tr>
<th>Type</th>
<th>1</th>
<th>1a</th>
<th>2</th>
<th>2a</th>
<th>3</th>
<th>3a</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Version</strong></td>
<td>Frame</td>
<td>Cabinet</td>
<td>Frame</td>
<td>Cabinet</td>
<td>Frame</td>
<td>Cabinet</td>
<td>Cabinet</td>
<td>Cabinet</td>
<td>Cabinet</td>
</tr>
<tr>
<td><strong>Width [mm]</strong></td>
<td>600</td>
<td>630</td>
<td>600</td>
<td>630</td>
<td>600</td>
<td>630</td>
<td>1230</td>
<td>1230</td>
<td>1430</td>
</tr>
<tr>
<td><strong>I&lt;sub&gt;EN&lt;/sub&gt; [A]</strong></td>
<td>45*</td>
<td>45</td>
<td>107*</td>
<td>107</td>
<td>187*</td>
<td>187</td>
<td>373</td>
<td>538</td>
<td>776</td>
</tr>
<tr>
<td><strong>U&lt;sub&gt;1max&lt;/sub&gt; [V&lt;sub&gt;AC&lt;/sub&gt;]</strong></td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td><strong>I&lt;sub&gt;fn&lt;/sub&gt; [A&lt;sub&gt;DC&lt;/sub&gt;]</strong></td>
<td>41</td>
<td>41</td>
<td>97</td>
<td>97</td>
<td>170</td>
<td>170</td>
<td>339</td>
<td>489</td>
<td>705</td>
</tr>
<tr>
<td><strong>I&lt;sub&gt;pl&lt;/sub&gt; [A&lt;sub&gt;DC&lt;/sub&gt;]</strong></td>
<td>53*</td>
<td>53</td>
<td>126*</td>
<td>126</td>
<td>221*</td>
<td>221</td>
<td>441</td>
<td>636</td>
<td>917</td>
</tr>
<tr>
<td><strong>T&lt;sub&gt;u&lt;/sub&gt; [°C]</strong></td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td><strong>Protection class</strong></td>
<td>IP00</td>
<td>IP21</td>
<td>IP00</td>
<td>IP21</td>
<td>IP00</td>
<td>IP21</td>
<td>IP21</td>
<td>IP21</td>
<td>IP21</td>
</tr>
<tr>
<td><strong>f&lt;sub&gt;n&lt;/sub&gt; [Hz]</strong></td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
<td>50/60</td>
</tr>
</tbody>
</table>

* Frame installed in a cabinet with protection class IP 21
** Higher ambient temperature and protection class on request

### Options

- Excitation transformer (built into cabinet)
- Start-up resistor
- Cable marking
- Interior cabinet lighting
- Standstill heating
- Display instruments on the door (voltmeter and ammeter)
- EMERGENCY OFF button on the door
- Fieldbus adapter for Profbus DP (12 MB)
- Fieldbus adapter for MODBUS or MODBUS+
- Protection against accidental contact with live parts when door is open
- Higher cabinet protection class
- Base plate (without openings for cables)
- Different cabinet painting (RAL colors)
- Insulation monitoring (includes rotor earth fault protection)
- Measured value transformer ±10V/4...20 mA for external display of field voltage and/or field current
- Commissioning and Maintenance Tool – CMT 5000
- Remote diagnostics
- Service contract
- Spare parts

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Dimensions of cabinet (height x depth) 2000 x 600 mm
Dimensions of frame (height x depth) 1800 x 350 mm
Cabinet painting RAL 7035 – Light grey

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I<sub>EN</sub> Nominal output current of the excitation
U<sub>1max</sub> Maximum input voltage
I<sub>fn</sub> Nominal field current of the motor
I<sub>pl</sub> Ceiling current (max. 10 s)
T<sub>u</sub> Ambient temperature
f<sub>n</sub> Nominal frequency
Technical design of a motor excitation system

What we need to know about your motor

1. **Motor data**
   Data on the machine including reactances, time constants, field data, excitation requirement for different load points, torque and load characteristic

2. **Start-up method**
   Which method is used to start up the machine?
   - Start-up using pony motor
   - Synchronous start-up with frequency converter
   - Asynchronous start-up (direct or with start-up transformer or limiter choke)

3. **Start/stop sequence, interfaces**
   How should the excitation system be integrated into the installation?

4. **Operating concept**
   How is the motor to be regulated in operation?
   - Voltage regulator mode to support the medium-voltage network
   - Cos φ regulator (direct or superimposed) or
   - Reactive power regulator (direct or superimposed)

5. **Definition of options**
   - Power supply to the excitation system
   - Additional functions
   - Cabinet design

For detailed specifications, please request the questionnaire for the design of a motor excitation system.

Simulation of the start-up of a synchronous motor

ABB has developed the program “SMTS” (Synchronous Machine Transient Simulation) in order to simulate the start-up of a synchronous motor and its influence on the supplying network. A study can be made or the program can be purchased upon request.

**Specified data:**
- Motor power: 5.2 MW
- Motor voltage: 6 kV
- Nominal frequency: 50 Hz

**Calculated data:**
- Starting resistor: 1.2 Ohm

Fig. 9: Torque characteristic and load characteristic of a pump drive

Fig. 10: Asynchronous start-up of a synchronous motor; simulation carried out in order to check value and thermal capacity of starting resistor
Your motor will thank you for it

ABB’s decades of experience in the area of excitation systems for synchronous machines ensures that you will have an excitation system for your motor that guarantees a both gentle run-up and safe operation of the machine, assisted by the modern microprocessor technology available.

By applying the excitation start-up at the right moment, reactive power shocks are largely avoided so that it is possible to operate a motor even under critical network supply conditions. The flexibility of the UNITROL excitation systems also makes it possible to realize more complex applications, for example, more complicated start and stop sequences.

Asynchronous start of a motor with static excitation and start-up transformer
UNITROL F data recording and analysis using the Commissioning and Maintenance Tool “CMT 5000”

Start-up sequence
1. Asynchronous start-up
2. Excitation ON, attainment of synchronism
3. Star-point switch (S2) opens
4. Shorting switch (S3) closes
5. Start-up resistance cuts out

UNITROL® – The best choice