GRIDCON® iTAP®
ON-LOAD TAP-CHANGER FOR DISTRIBUTION GRIDS.
ECONOMICALLY INTEGRATING RENEWABLE ENERGIES INTO THE GRID.

RUNNING INDUSTRIAL PROCESSES STABLY WHILE OPTIMIZING ENERGY CONSUMPTION.
Distribution transformers with on-load tap-changers ensure that the voltage in public and industrial distribution grids remains stable by balancing fluctuations in the medium voltage and dynamically reacting to supply and load changes in the low voltage.

This means that additional renewable energies can be incorporated into the distribution grid without having to perform expensive grid expansion work. They make it easier to connect wind farms and solar parks without incurring excessive costs, stabilize industrial processes, and even help to keep energy costs in industrial environments low. What’s more, thanks to actively selected voltage levels, they even make it possible for electrical distribution grids to operate in a way that keeps losses as low as possible.

The unique advantage of the GRIDCON® iTAP® is that it does not affect transformer dimensions or reliability compared with unregulated transformers. Its primary technology can even go for decades without the need for maintenance. This means that transformers with GRIDCON® iTAP® can replace existing transformers without needing to free up additional space.
GRIDCON® iTAP® – EVERYTHING YOU NEED FOR VOLTAGE REGULATION IN DISTRIBUTION GRIDS.

Since first hitting the market in 2012, GRIDCON® iTAP® has been the world’s leading solution for voltage regulation in distribution transformers. It is based on the on-load tap-changer experience acquired by the global market leader Maschinenfabrik Reinhausen (MR) since 1929, which it expertly incorporates into the distribution grid.

The GRIDCON® iTAP® system solution comes complete with all the functions necessary to facilitate voltage regulation in a distribution transformer:

- The on-load switching function allows the transmission ratio between the upper and lower voltage in the transformer to be dynamically adjusted under load.
- The drive function guarantees a reliable switching sequence.
- The control and regulation function not only serves as the interface to the user, but also as the logic which uses algorithms to both determine and trigger switching operations.
Control and regulation function

- Autonomous voltage regulation based on the measured voltage (optionally also current or power)
- Option to include remote sensors in the regulation system
- Integration into overarching regulation concepts
- Three-phase voltage measurement
- Storage of power-quality measurements on an SD card (optional)
- Automatic, remote, and manual modes
- Raise and lower operations
- Ethernet interface
- IEC 60870-5-104 communication protocol, MODBUS TCP optional
- IP54 level of protection

On-load switching function

- On-load tap-changer based on the reactor principle
- Arc quenching in specially developed vacuum interrupters
- Fitted in transformer tank above the active part
- Maintenance-free over the life of the transformer (up to 700,000 tap-change operations)
- Regulation on the high-voltage side
- 3 phases
- Maximum of 9 operating positions – alternatively, 5 or 7
- Freely configurable regulating range, e.g., ± 4 x 2.5 percent (maximum 600 V step voltage)
- Maximum rated through-current of 30 A or 85 A
- 24 kV voltage range

Drive function

- Stepping motor
- Fitted on the transformer cover above the on-load tap-changer
- Suitable for outdoor installation, IP65 level of protection
- Each tap-change operation lasts around 2 seconds

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MAXIMUM CONFIGURATION FREEDOM – SIMPLE OPERATION AND COMMISSIONING ON SITE.

**Browser-based multi-lingual interface**
- Operation via TCP/IP possible once connected to the Ethernet interface without the need for additional software
- Password protection against unauthorized operation

**Comprehensive status information**
- Displays the most important system states, such as the operating mode, tap position, and operations count
- Displays the present U, I, P, Q, S, and cos(φ) – even for the remote measuring points
- Digital drag hands for U_{max} and U_{min} per phase, as well as P_{max} and P_{min}
- Time-based and quantity-based evaluation for each tap position
- Storage of power-quality measurements on an SD card (optional)
- Error storage in the interface and on an SD card

**Configurable remote communication**
- Communication via IEC 60870-5-104 and optional MODBUS TCP
- Flexible network integration
- Freely configurable IOAs in IEC 60870-5-104
- Transmission of system statuses and measured values
- Aggregated transmission of measured values from the remote sensors
- Remote control and remote parameterization possible

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**System data**
- **System status**: OK
- **Status**: Auto, Man, Rem
- **Operations**: 24786
- **Serial number**: 1234567

**Extended settings**

**Measured values**
- **Tap position**: 5
- **Measurement point**: Busbar
- **Voltage [V]**: 230.0, 230.0, 230.0
- **Current [A]**: 0.0, 0.0, 0.0
- **Active power [kW]**: 0.0, 0.0, 0.0
- **Reactive power [kvar]**: 0.0, 0.0, 0.0
- **Output factor**: 0.0, 0.0, 0.0

**SCADA**
- **Communication protocol**: IEC 60870-5-104, MODBUS TCP
- **Time-out interval for SCADA [s]**: 100
- **Overvoltage warning [V]**: 265.0
- **Undervoltage warning [V]**: 195.0

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**Detail settings SCADA**
Operating behavior settings

- Operation without additional no load losses by skipping intermediate positions
- Regulating range limitation
- Current measurement, voltage blocking, and behavior in the event of a communication failure

Selecting the regulation algorithm

- Low-voltage busbar for desired voltage value
- Low-voltage busbar for current-dependent and load-dependent desired voltage value (optional)
- Remote sensor desired voltage value, critical-node regulation (optional)
- Multi-sensor regulation system (optional)

Configuration of remote sensors

- Interaction with up to four remote sensors
- Communication via IEC 60870-5-104
- Transmission of U, I, P, Q, S, and cos(phi)

Parameterizing the regulation algorithm

- Desired voltage values, bandwidths, and delay times
- Characteristic curves
- Weighting of different measuring points
- Behavior if remote sensors fail
- Behavior in phase imbalance
THE IDEAL REGULATION CONCEPT FOR EVERY REQUIREMENT.

Connection to an upstream control room as an extension to the local operation

- Connection via IEC 60870-5-104 or optional MODBUS TCP
- Agnostic with respect to the communication route, e.g., GPRS, UMTS, power line, or fiber optics possible
- Direct control via switching commands allows integration into wide-range control systems
- Changing the parameters of the local regulation algorithms allows adaptation to altered grid conditions
- Transmission of GRIDCON® iTAP® system statuses and measured data from the transformer (U, I, P, Q, S, cos(\phi))
- Aggregated transmission of measured data from remote sensors (U, I, P, Q, S, cos(\phi))

Connecting remote sensors

- Connection via IEC 60870-5-104
- Agnostic with respect to the communication route, e.g., GPRS, UMTS, power line, or fiber optics possible
- Aggregated transmission of sensor measured data to GRIDCON® iTAP® (U, I, P, Q, S, cos(\phi))
- Measured data from the sensor can be used in GRIDCON® iTAP® for regulation and can be passed on to an upstream control room in aggregated form
- Sensors of various models and levels of protection are available from MR
Autonomous voltage regulation – various algorithms available

1. Fixed desired voltage value for the low-voltage busbar: The standard regulation concept is based on the three-phase measurement of the actual voltage on the low-voltage side of the transformer and on the regulation to a preconfigured desired voltage value.

2. Load-dependent or current-dependent desired voltage value for the low-voltage busbar (optional): In addition to the standard regulation concept, the desired voltage value for the low-voltage side of the transformer is dynamically adapted by a characteristic curve depending on the measured apparent power or the measured current.

3. Fixed desired voltage value for a remote sensor, critical-node regulation (optional): Rather than the voltage on the low-voltage side of the transformer, the voltage of a remote measuring point is used as the input value for voltage regulation. This value is transmitted via sensors – which are available in various models – to GRIDCON® iTAP®, where it is compared with a preset desired voltage value.

4. Optimization of the entire system via multiple remote sensors in the grid (optional): In more complex grids with multiple sensors, information from various remote measuring points can be used in conjunction with the voltage on the low-voltage side of the transformer to realize a total optimum voltage in the network.
MORE POWER, MORE VALUE.

The professional solution for operators of public or private distribution grids.

Maintenance free and long lasting

- As there are no electronic components in the primary technology, the on-load tap-changer service life is the same as that of an unregulated transformer
- Tried-and-tested vacuum technology categorically prevents transformer oil contamination by arcs and ensures that the primary technology stays maintenance free
- The GRIDCON® iTAP® is the product of all our experience since 1929. Over 50,000 of our on-load tap-changers in vacuum technology have already been supplied

Maximum operational reliability

- The reactor principle – tried and tested since 1905 – on which the GRIDCON® iTAP® is based systematically prevents critical operating states
- GRIDCON® iTAP® has undergone mechanical and electrical service life tests well beyond the requirements of IEC standards
- As a component of GRIDCON® transformers, GRIDCON® iTAP® has been certified by the FGH certification office (standards IEC 60076, IEC 60214-1, IEC 61000, EN 50160)

Low life-cycle costs

- 700,000 reliable tap-change operations means maintenance is not required – throughout the entire service life of a transformer; the secondary technology can simply be replaced if necessary
- Depending on the technical configuration, operation is possible without additional losses in the transformer
- As a tap changer based on the established reactor principle, GRIDCON® iTAP® can be easily integrated into existing transformer designs

Designed with future requirements in mind

- The large regulating range of up to 24% in a 20 kV grid ensures that even currently unknown voltage challenges can be fully corrected
- The fact that the parameters for the regulation algorithms can be set so easily ensures flexible adaptation to future grid conditions
- The integration of remote sensors into the voltage regulation and the integration of GRIDCON® iTAP® into the regulation concepts can also be performed at a later date

Simple handling for transformer manufacturers and grid operators

- Conventional work steps and tools can be used to electrically and mechanically connect GRIDCON® iTAP® in the transformer
- Commissioning by the grid operator is almost identical to that of an unregulated transformer and can be carried out by the same personnel
- Basic operation is performed via large switches, keys, and display instruments. Detailed configuration of the system behavior is performed via a web-based user interface
FORWARD LOOKING AND ENVIRONMENTALLY FRIENDLY.

Important topics that are set to gain in significance for distribution transformers in the future include low losses, the use of environmentally compatible insulating liquids, and – in the field of renewable energies – the certification of system and component grid conformity. GRIDCON® iTAP® is already ideally prepared for all three of these issues, which helps manufacturers of voltage regulation distribution transformers to offer products that are fully capable of meeting future market requirements.

**Low losses – EU Ecodesign**

The EU Ecodesign Directive for transformers will set new maximum limits for transformer no load and load losses in two stages from mid 2015 and mid 2021. In order to prevent a negative influence on the total losses of a voltage regulation distribution transformer, the additional losses resulting from the use of GRIDCON® iTAP® in the transformer are below the additional loss allowances granted by the European Commission for equipment designed to change voltage under load. What’s more – if the transformer is designed accordingly – a software setting enables the GRIDCON® iTAP® to be operated without any additional no load losses in the transformer by skipping the intermediate positions. This means that transformers with GRIDCON® iTAP® are already prepared for the requirements of the Ecodesign Directive that will apply from mid 2021.

**Alternative insulating liquids**

Compared with mineral oils, alternative insulating liquids for transformers offer greater environmental compatibility and fire protection. This means that these liquids are becoming more important in the distribution grid. So that it can be used in all voltage regulation distribution transformers, the use of GRIDCON® iTAP® is permitted in both selected synthetic and natural esters at an adjusted minimum oil temperature:

- Synthetic ester: MIDE 7131 (M&I)
- Natural ester: Envirotemp FR3 (Cargill)

The use of GRIDCON® iTAP® in alternative insulating liquids other than those specified can be clarified with our experts as a special application.

**Grid conformity as a grid-regulating unit and as an optional part of generation plants**

Decentralized power generation plants based on renewable energies (PV, wind, biogas) must meet the grid operator’s local requirements for grid integration in the form of the applicable grid connection rules. These also frequently oblige generation plant manufacturers to provide evidence of the electrical properties of the systems and require type tests that can be proven with certificates. As a part of the GRIDCON® Transformer and as the first product of its kind in the world, GRIDCON® iTAP® already proved conformity with the product certification guidelines for grid regulation units of the FGH certification office back in 2013. Testing for this certification under the co-applicable standards IEC 60076, IEC 60214-1, IEC 61000, and EN 50160 covered operational reliability, grid compatibility, and controller functionality.
## TECHNICAL DATA – ON-LOAD TAP-CHANGER.

<table>
<thead>
<tr>
<th>On-load tap-changer</th>
<th>iTAP® III 30 A</th>
<th>iTAP® III 85 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equalizer winding</td>
<td>None</td>
<td>With</td>
</tr>
<tr>
<td>Number of phases</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Application</td>
<td>At any point in the winding</td>
<td></td>
</tr>
<tr>
<td>Max. rated through-current $I_{um}$ (A)</td>
<td>30</td>
<td>85</td>
</tr>
<tr>
<td>Corresponding transformer power at 20 kV (MVA)</td>
<td>1.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Corresponding transformer power at 10 kV (MVA)</td>
<td>0.8</td>
<td>2.25</td>
</tr>
<tr>
<td>Rated short-time current (in A)</td>
<td>600</td>
<td>1,700</td>
</tr>
<tr>
<td>Rated duration of short circuits (in s)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rated peak withstand current (in A)</td>
<td>1,500</td>
<td>4,250</td>
</tr>
<tr>
<td>Max. rated step voltage $U_{sm}$ (in V)</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Max. rated tapping voltage $U_{im}$ (in V)</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Step capacity $P_{StN}$ (in VA)</td>
<td>18,000</td>
<td>51,000</td>
</tr>
<tr>
<td>Rated step voltage $U_{i}$ [V]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated through-current $I_{u}$ [A]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GRIDCON® iTAP® step capacity diagram**

- **iTAP® III 85 with equalizer winding**: 51,000 VA
- **iTAP® III 30**: 18,000 VA

**Rated insulation level**
- Highest voltage for equipment $U_{e}$ (in kV): 24
- Rated lightning impulse withstand voltage (in kV, 1.2/50 μs): 125
- Rated short-duration power frequency withstand voltage (in kV, 50 Hz, 1 min.): 50
- Rated frequency (in Hz): 50

**Temperature range of transformer oil**
- -25 °C to +105 °C

**Permissible absolute pressure during operation (in bar)**
- min. 0.7 / max. 1.3

**Max. number of tap-change operations**
- 700,000
- 500,000
Mechanical installation

- Simple winding arrangement
- Losses through circulating currents only occur in bridging tap-changer positions
- Larger and heavier reactors with higher losses
- When the rated through-current is > 30 A, the rated step voltage must be 300 V

Electrical connection

Version 1: Without equalizer winding
- Smaller and lighter reactors with lower losses
- When the rated through-current is > 30 A, the rated step voltage can be up to 600 V
- Losses through circulating currents occur in all tap changer positions
- Complex winding arrangement

Version 2: With equalizer winding
TECHNICAL DATA – VOLTAGE REGULATOR AND CONTROL CABINET.

<table>
<thead>
<tr>
<th>Voltage regulator and control cabinet</th>
<th>iTAP® III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>3 AC 400 V</td>
</tr>
<tr>
<td>Current</td>
<td>1 A</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Test voltage to ground</td>
<td>2 kV / 1 minute</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-20 °C... +50 °C</td>
</tr>
<tr>
<td>Interface</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Protocol</td>
<td>IEC 60870-5-104, MODBUS TCP (optional)</td>
</tr>
</tbody>
</table>
| Housing (W x H x D) | 380 x 380 x 210 mm  
400 x 500 x 210 mm  
200 x 800 x 152 mm |

![Diagram of voltage regulator and control cabinet]
Please note:
The data in our publications may differ from
the data of the devices delivered. We reserve
the right to make changes without notice.