The On-Load Tap-Changer for Maximum Switching Frequency – More Switching Operations without Needing Maintenance.
Today's on-load tap-changers for regulating transformers are subject to very extreme demands. Our answer to this is the new VACUTAP® VR I HD – steady further development of the VACUTAP® VR vacuum on-load tap-changer which has been providing reliable service since 2004. The new on-load tap-changer which is optimized for applications with high, above average switching rates performs even more switching operations without maintenance, thus giving you more transformer operating time. And the best thing about all this: Almost all VACUTAP® VR I's delivered up to now can be retrofitted.

Developed for maximum switching frequencies – take advantage of longer maintenance intervals.

The new VACUTAP® VR I HD does not have time-based maintenance. Instead the next maintenance job is not performed until after the VACUTAP® VR I HD has performed 600,000 switching operations. The diverter switch insert doesn’t even need to be replaced until after 1.2 million switching operations. This means a further reduction in operating costs coupled with maximum quality and highest environmental and safety standards. You profit from short down times and maximum productivity.

To be able to ensure this quality at all times, we depend on the exclusive use of vacuum interrupters for the VACUTAP® VR I HD – as with all VACUTAP® on-load tap-changers. These vacuum interrupters were especially developed and optimized for use in on-load tap-changers. They are manufactured exclusively in accordance with our strict specifications and have been giving dependable service now for years.

Advantages: Maintenance intervals increased to 600,000 switching operation, added cost reduction over the entire useful life of the VACUTAP® VR I HD.

Ready to handle harshest of demands – at all times.

The new VACUTAP® VR I HD guarantees precise switching procedures under the harshest of conditions. This also includes applications such as electrolysis, phase shifters or HVDC (High Voltage Direct Current) transmission in addition to furnace operation.

MR vacuum on-load tap-changers are not only used worldwide in many steel and aluminum mills but also on drilling rigs in potentially explosive environments or in chemical plants with aggressive or polluted surroundings. Since MR is the first and the sole manufacturer of on-load tap-changers that has had the VV and VR on-load tap-changers certified in accordance with 94/9/EG (ATEX) guidelines (in conformance with IEC and NEC 505 in North America).

Advantage: Precise switching procedures even under the most extreme of conditions.
The World Market’s Leading Company – the Perfect Partner for Those Who Expect Only the Best

Vacuum technology is distinguished by its low power consumption during the switching-off procedure in the vacuum interruption. Due to the hermetically sealed switching chambers, arcs never occur in contact with the extinguishing agent. This makes the switching characteristics independent of the surrounding medium.

Advantages:
• No current arc in the on-load tap-changer
• No oil filter system needed
• Clean oil simplifies and speeds up maintenance work
• No oil filter system needed
• No cutoff arcing in the on-load tap-changer oil

Extra:
• Much lower maintenance frequency in comparison to conventional oil switching technology
• Environmentally-friendly operation, low disposal costs for soiled insulating fluids.

Vacuum interrupters made exclusively for MR – optimized for use in on-load tap-changers.

Your advantage even in upgraded or newly-purchased technology – VACUTAP® VR I HD modules allow use – standardized for IP 66 class protection and available as version with ATEX 95 certification.

Based on more than 80 years of experience in this specialist field.

MR on-load tap-changers. Behind this is our edge in expertise, gained from more than 80 years of experience in this specialist field.

Our experts are familiar with the requirements of both end customers and transformer manufacturers. This knowledge drives our innovations and is also used to provide challenging special solutions. In addition, it enables us to continuously set new standards, which are then used by the entire industry sector. We use our research and development center in Regensburg, unique worldwide, for this purpose. Every product that leaves our company has been tested against the applicable standards and beyond. That’s how we ensure that our customers get exactly what they expect from us – future-free regulation of their transformers, even under extreme conditions and over a period of several years.

Our responsibility does not stop at delivery. We will remain your absolutely reliable partner over the entire lifetime of the product. And that can be 50 years or more. Even after this time, our customers will receive the necessary service, maintenance and spare parts. Because what we make lasts a long time. That’s a sure thing.

Maximum precision and perfection are demanded of our products – and that of course applies for our service as well. To ensure this, we depend on a unique, closely-knit, worldwide network made up of certified premium service providers. These premium service providers are thoroughly trained in accordance with our regulations and also attend instruction courses at regular intervals.

MR service means:
• 24-month warranty on all services
• Service engineers on site within 24 hours
• Access to original MR spare parts over decades
• Experience gained from thousands of service calls
• Preparation of individual service strategies
• Training courses for your service personnel at our training centers.

MR tested – maximum safety during long-term operation.

Advantages:
• Almost all VACUTAP® VR I HD modules, which have been delivered up to now can be retrofitted.

Environmental-friendly technology – sustainable during daily use.

The VACUTAP® VR I HD is distinguished by its environmentally-friendly vacuum technology. In contrast to conventional oil switching technology, we ensure that no carbon arcs are created in the insulating oil. This means you don’t need an oil filter system either during operation. In addition, the new generation of on-load tap-changers is designed for selected, alternative insulating fluids.

Environmentally-friendly operation, low disposal costs for solid insulating fluids.

Transformer Control
On-Load Tap-Changers

The dacton service network worldwide – no matter where you are; we are close by.

The densest service network worldwide – no matter where you are, we are close by.

MR on-load tap-changers. Behind this is our edge in expertise, gained from more than 80 years of experience in this specialist field.

MR tested – maximum safety during long-term operation.

Environmentally-friendly technology – sustainable during daily use.

The VACUTAP® VR I HD is distinguished by its environmentally-friendly vacuum technology. In contrast to conventional oil switching technology, we ensure that no carbon arcs are created in the insulating oil. This means you don’t need an oil filter system either during operation. In addition, the new generation of on-load tap-changers is designed for selected, alternative insulating fluids.

Environmentally-friendly operation, low disposal costs for solid insulating fluids.

Transformer Control
On-Load Tap-Changers

The densest service network worldwide – no matter where you are; we are close by.

MR tested – maximum safety during long-term operation.

Environmentally-friendly technology – sustainable during daily use.

The VACUTAP® VR I HD is distinguished by its environmentally-friendly vacuum technology. In contrast to conventional oil switching technology, we ensure that no carbon arcs are created in the insulating oil. This means you don’t need an oil filter system either during operation. In addition, the new generation of on-load tap-changers is designed for selected, alternative insulating fluids.

Environmentally-friendly operation, low disposal costs for solid insulating fluids.
### Transformer Control

**On-load Tap-Changers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of phases</th>
<th>Max. rated through current $I_{u}$ (in A)</th>
<th>Rated short-time current (in kA)</th>
<th>Rated short-circuit duration (in s)</th>
<th>Rated short-circuit current (in kA)</th>
<th>Max. rated step voltage $U_{i}$ (in V)</th>
<th>Switching capacity $P_{StN}$ (in kVA)</th>
<th>Rated frequency (in Hz)</th>
<th>Operating positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VACUTAP ® VRC</td>
<td>1</td>
<td>400</td>
<td>6</td>
<td>3</td>
<td>25</td>
<td>1300</td>
<td>1010</td>
<td>50...60</td>
<td>1</td>
</tr>
<tr>
<td>VACUTAP ® VRE</td>
<td>1</td>
<td>550</td>
<td>12</td>
<td>3</td>
<td>37</td>
<td>1300</td>
<td>1510</td>
<td>50...60</td>
<td>1</td>
</tr>
<tr>
<td>VACUTAP ® VRD</td>
<td>1</td>
<td>700</td>
<td>15</td>
<td>3</td>
<td>37</td>
<td>1300</td>
<td>2010</td>
<td>50...60</td>
<td>1</td>
</tr>
<tr>
<td>VACUTAP ® VRF</td>
<td>1</td>
<td>1000</td>
<td>20</td>
<td>3</td>
<td>37</td>
<td>1300</td>
<td>3010</td>
<td>50...60</td>
<td>1</td>
</tr>
<tr>
<td>VACUTAP ® VRG</td>
<td>1</td>
<td>1300</td>
<td>25</td>
<td>3</td>
<td>37</td>
<td>1300</td>
<td>3710</td>
<td>50...60</td>
<td>1</td>
</tr>
</tbody>
</table>

*4500 kVA: special order with multiple coarse change-over selector possible up to a max. of 100 positions.

---

**On-load Tap-changer Designations**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of phases</th>
<th>Number of parallel sectors</th>
<th>$U_{i}$ (in kV)</th>
<th>Tap selector series</th>
<th>Number of max. operating positions</th>
<th>Change-over selectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>VACUTAP ® VRC</td>
<td>1</td>
<td>1</td>
<td>72,5</td>
<td>A</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>VACUTAP ® VRE</td>
<td>1</td>
<td>1</td>
<td>123</td>
<td>B</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>VACUTAP ® VRD</td>
<td>1</td>
<td>1</td>
<td>170</td>
<td>C</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>VACUTAP ® VRF</td>
<td>1</td>
<td>1</td>
<td>245</td>
<td>D</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>VACUTAP ® VRG</td>
<td>1</td>
<td>1</td>
<td>300</td>
<td>E</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

---

**On-load Tap-changer Designations (continued)**

- VACUTAP ® VRC, VRE: 10% violation in excess of the max. rated step voltage caused by overexitation of the transformer is permitted if the switching capacity is not exceeded too.
- VACUTAP ® VRD, VRF, VRG: special model with multiple coarse change-over selector possible up to a max. of 100 positions.

---

**Example**

- Switching capacity diagram, VRC-VRE I HD in arcing furnace operation
- Switching capacity diagram, VRD-VRF I HD in arcing furnace operation
Advantages over conventional oil switching technology

Vacuum technology is distinguished by its low power consumption during the switch-off procedure in the vacuum interruption. Due to the hermetically sealed switching chambers, arcs never come in contact with the extinguishing agent. This makes the switching characteristics independent of the surrounding medium.

Advantages:
• No catalytic acting in the on-load tap-changer oil
• No oil filter system needed
• Chan-coil simplifies and speeds up maintenance work
• Much lower maintenance frequency compared to conventional oil switching technology.

Extra:
The constant switching capacity over the entire lifespan of the vacuum interrupters. The vacuum quality in the tubes is improved even more during the switching procedure because the metal vapor plasma created by the arc binds free gas molecules from the contact material (getter effect). In addition, there is no oxidation of the contact surface. This ensures a uniformly good transition resistance.

Easy offer preparation – simplified planning and ordering.
To be able to prepare your offer that is customized to your needs, we usually only need a current/typical take-off from the transformer manufacturer in addition to the basic data of the transformer. We will contact the transformer manufacturer for you if further questions should arise during the design of the on-load tap-changer.

Advantages:
High degree of transparency, clear cost structure.

The World Market’s Leading Company – the Perfect Partner for Those Who Expect Only the Best

Machinaelektrik Reinhausen GmbH (MR) is the largest company of the REINHAUSEN Group, both in sales and number of employees. Founded in 1901, MR is today considered the world’s leading premium provider of on-load tap-changers for regulating power transformers.

Our experience and expertise gained from more than 80 years of experience in this specialist field.

Innovation – more than 50% of the world’s electrical current flows through MR on-load tap-changers. Behind this is our edge in expertise, gained from more than 80 years of experience in this specialist field.

Our experts are familiar with the requirements of both end customers and transformer manufacturers. This knowledge drives our innovations and is used to provide challenging special solutions. In addition, it enables us to continually set new standards, which are then used by the entire industry sector. We use our research and development center in Regensburg, unique worldwide, for this purpose. Every product that leaves our company has been tested against the applicable standards and beyond. That’s how we ensure that our customers get exactly what they expect from us – failure-free regulation of their transformers, even under extreme conditions and over a period of several years.

Our responsibility does not stop at delivery. We will remain your absolutely reliable partner over the entire lifetime of the product. And that can be 50 years or more. Even after this time, our customers will receive the necessary service, maintenance and spare parts. Because we make products that last a long time. That’s a sure thing.

The densest service network worldwide – no matter where you are, we are close by.
Maximum precision and perfection are demanded of our products – and that of course applies for our service as well. To ensure this, we depend on a unique, closely-knit, worldwide network made up of certified premium service providers. These premium service providers are thoroughly trained in accordance with our regulations and also attend instruction courses at regular intervals.

**VACUTAP® VR I HD**

Transformer Control
On-Load Tap-Changers

VACUTAP® VR I HD

Can be 100% retrofitted – easy to install later on.
The VACUTAP® VR I HD can be retrofitted and is fully compatible with almost all already delivered VACUTAP® VR I on-load tap-changers. Easy to change since the dimensions of the diverter switch insert are the same as those of almost all VACUTAP® VR I’s delivered up to now.

Advantages:
Almost all VACUTAP® VR I OLTCs, which have been delivered up to now, can be retrofitted.

**MR tested** – maximum safety during long-term operation.
We also followed MR’s philosophy of strict protection when we developed the VACUTAP® VR I HD. In our worldwide unique test lab, this OLTC was subjected to mechanical and electrical lifespan tests with far higher demands than IEC standards require. For example, switching capacity trials were performed with 602,000 switching operations instead of the required 50,000 switching operations.

Advantages:
Unbeatable safety during daily operation.

**Environmentally-friendly technology** – sustainable during daily use.
The VACUTAP® VR I HD is distinguished by its environmentally-friendly vacuum technology. In contrast to conventional oil switching technology, we ensure that no cutoff arcs are created in the insulating oil. This means you don’t need an oil filter system either during operation. In addition, the new generation of on-load tap-changers is designed for selected, alternative insulating fluids.

Advantages:
Environmentally-friendly operation, low disposal costs for used insulating fluids.

**Transformer Control**

**On-Load Tap-Changers**

VACUTAP® VR I HD

**Training courses for your service personnel at our training centers**

| Experience gained from thousands of service calls |
| Access to original MR spare parts over decades |
| Service engineers on site within 24 hours |
| 24-month warranty on all services |
On-load tap-changer

<table>
<thead>
<tr>
<th>Type</th>
<th>VACUTAP ® VRC</th>
<th>VACUTAP ® VRD</th>
<th>VACUTAP ® VRE</th>
<th>VACUTAP ® VRF</th>
<th>VACUTAP ® VRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of phases</td>
<td>1 phase</td>
<td>1 phase</td>
<td>1 phase</td>
<td>1 phase</td>
<td>1 phase</td>
</tr>
<tr>
<td>Max. rated through current (I&lt;sub&gt;u&lt;/sub&gt; in A)</td>
<td>400</td>
<td>550</td>
<td>700</td>
<td>1000</td>
<td>1300</td>
</tr>
<tr>
<td>Rated short-time current (I&lt;sub&gt;S&lt;/sub&gt; in kA)</td>
<td>10</td>
<td>15</td>
<td>18</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Rated short-circuit duration (t&lt;sub&gt;c&lt;/sub&gt; in s)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rated short-circuit current (I&lt;sub&gt;l&lt;/sub&gt; in kA)</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>37.5</td>
</tr>
<tr>
<td>Max. rated step voltage U&lt;sub&gt;i&lt;/sub&gt; (in V)</td>
<td>3300</td>
<td>3300</td>
<td>3300</td>
<td>3300</td>
<td>3300</td>
</tr>
<tr>
<td>Switching capacity P&lt;sub&gt;stN&lt;/sub&gt; (in kVA)</td>
<td>1320</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Rated frequency (in Hz)</td>
<td>50...60</td>
<td>50...60</td>
<td>50...60</td>
<td>50...60</td>
<td>50...60</td>
</tr>
</tbody>
</table>
| Operating positions | 10% violation in excess of the max. rated step voltage caused by overexcitation of the transformer is permitted if the switching capacity is not exceeded too.
Without change-over selector: max. 18, with change-over selector: max. 35.

Switching capacity diagram, VRC-VRE I HD in arcing furnace operation

Switching capacity diagram, VRD-VRF I HD in arcing furnace operation

---

Example

- **VRD**
  - VRD I 1301
  - VRD I HD 1301
- **VRG**
  - VRG I 1001
  - VRG I HD 1301

---

Transformer Control
On-Load Tap-Changers
### Transformer Control

#### On-Load Tap-Changers

<table>
<thead>
<tr>
<th>Transformer Control</th>
<th>VACUTAP® VR I HD On-Load Tap-Changers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>VACUTAP® VRC VRD VRE VRF VRG</td>
</tr>
<tr>
<td><strong>Number of phases</strong></td>
<td>1 phase I I I I I</td>
</tr>
<tr>
<td><strong>Um (in kV)</strong></td>
<td>72,5 72,5 72,5 72,5 72,5</td>
</tr>
<tr>
<td><strong>I um (in A)</strong></td>
<td>400 550 700 1000 1300</td>
</tr>
<tr>
<td><strong>Number of parallel sectors</strong></td>
<td>1 sector 1</td>
</tr>
<tr>
<td><strong>Tap selector series</strong></td>
<td>VRC, VRE B C D DE VRG E</td>
</tr>
<tr>
<td><strong>Number of max. operating positions</strong></td>
<td>10 10</td>
</tr>
<tr>
<td><strong>Number of max. operating positions with change-over selector</strong></td>
<td>12 12</td>
</tr>
<tr>
<td><strong>Mid positions</strong></td>
<td>0 Mid positions (without change-over selector) 0</td>
</tr>
<tr>
<td><strong>Change-over selectors</strong></td>
<td>Reversing change-over selector W Coarse change-over selector G</td>
</tr>
</tbody>
</table>

#### On-load tap-changer designations

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic circuit diagram</td>
</tr>
<tr>
<td>Transformer designation</td>
</tr>
<tr>
<td>Number of phases</td>
</tr>
<tr>
<td>Max. rated through current I um (in A)</td>
</tr>
<tr>
<td>Rated short-time current (in kA)</td>
</tr>
<tr>
<td>Rated short-circuit duration (in s)</td>
</tr>
<tr>
<td>Rated short-circuit current (in kA)</td>
</tr>
<tr>
<td>Rated step voltage U im (in V)</td>
</tr>
<tr>
<td>Switching capacity PStN (in kVA)</td>
</tr>
<tr>
<td>Rated frequency (in Hz)</td>
</tr>
<tr>
<td>Operating positions</td>
</tr>
</tbody>
</table>

---

1) 0.5% violation in terms of the max. rated step voltage caused by overexcitation of the transformer

2) VRD in special model with multiple coarse change-over selector possible up to a max. of 57 positions.
Advantages over conventional oil switching technology

Vacuum technology is distinguished by its low power consumption during the switching-off procedure in the vacuum interruption. Due to the hermetically sealed switching chambers, arcs never come in contact with the extinguishing agent. This makes the switching characteristics independent of the surrounding medium.

Advantage:
• No arcing acting in the on-load tap-changer oil
• No oil filter system needed
• No wear in the contact material (getter effect) In addition, there is no oxidation of the contact surface. This ensures a uniformly good transition resistances.

Easy offer preparation – simplified planning and ordering.

To be able to prepare your offer that is customized to your needs, we usually only need a current/voltage table from the transformer manufacturer in addition to the basic data of the transformer. We can usually only need a current/voltage table from the transformer manufacturer in addition to the basic data of the transformer. We therefore remain your absolutely reliable partner over the entire lifetime of the product. And that can be 50 years or more. Even after this time, our customers will receive the necessary service, maintenance and spare parts. Because we always make last a long time. That’s a sure thing.

The World Market’s Leading Company – the Perfect Partner for Those Who Expect Only the Best

Machnerdick Reinhausen GmbH (MR) is the largest company of the REINHAUSEN Group, both in sales and number of employees. Founded in 1901, MR is today considered the world’s leading premium provider of on-load tap-changers for regulating power transformers.

All our products meet highest standards when it comes to quality, reliability and long-life. Proof of our extraordinary market position - more than 50% of the world’s electrical current flows through MR on-load tap-changers. Behind all this is our edge in expertise, gained from more than 80 years of experience in this specialist field.

Our experts are familiar with the requirements of both end customers and transformer manufacturers. This knowledge drives our innovations and is also used to provide challenging special solutions. In addition, it enables us to continually set new standards, which are then used by the industry as a whole. For this reason, we always ensure that the vacuum interrupters we have tested against the applicable standards and beyond. That’s why we are sure that our customers get exactly what they expect from us – failure-free regulation of their transformers, even under extreme conditions and over a period of several years.

Our responsibility does not stop at delivery. We will remain your absolutely reliable partner over the entire lifetime of the product. And that can be 50 years or more. Even after this time, our customers will receive the necessary service, maintenance and spare parts. Because we always make last a long time. That’s a sure thing.

The most service network worldwide – no matter where you are, we are close by.

Maximum precision and perfection are demanded of our products and that of course applies for our service as well. To ensure this, we depend on a unique, closely-knit, worldwide network made up of certified premium service providers. These premium service providers are thoroughly trained in accordance with our regulations and also attend instruction courses at regular intervals.

VR service means:
• 24-hour warranty on all services
• Service engineers on site within 24 hours
• Access to original/VR spare parts over decades
• Experience gained from thousands of service calls
• Preparation of individual service strategies
• Training courses for your service personnel at our training centers.

Can be 100% retrofitted – easy to install later on.

The VACUTAP® VR I HD can be retrofitted and is fully compatible with almost all already delivered VACUTAP® VR I on-load tap-changers. Easy to change since the dimensions of the diverter switch insert are the same as those of almost all VACUTAP® VRs delivered up to now.

Advantage: Almost all VACUTAP® VR I OLTCs, which have been delivered up to now can be retrofitted.

MR tested – maximum safety during long-term operation.

We also followed MR’s philosophy of strict protection when we developed the VACUTAP® VR I HD. In our worldwide unique test lab, this OLTC was subjected to mechanical and electrical (thunder tests with far higher demands than IEC standards require. For example, switching capacity trials were performed with 600,000 switching operations instead of the required 50,000 switching operations.

Advantage: Un paralleled safety during daily operation.

Environmentally-friendly technology – sustainable during daily use.

The VACUTAP® VR I HD is distinguished by its environmentally-friendly vacuum technology. In contrast to conventional oil switching technology, we ensure that no arcuffs are created in the insulating oil. This means you don’t need an oil filter system either during operation. In addition, the new generation of on-load tap-changers is designed for selected, alternative insulating fluids.

Advantage: Environmentally-friendly operation, low disposal costs for solid insulating fluids.
Your one-stop provider – everything in MR quality.

MR is your reliable partner for all power transformer issues and system provider for all products in the areas of Power Transmission, Power Distribution, Automation & Control, Asset Management Solutions, Power Composites and Power Quality.

**Power Transmission, Power Distribution**
- On-load tap-changers VACUTAP®, OILTAP®
- Off-circuit tap-changers DEETAP®, COMTAP®
- Drives TAPMOTION®
- Temperature monitoring COMPACT, TRASY2
- Intelligent fan control MTeC®
- Flow indicators MFloC®
- Oil level indicators MTO, MMK
- Dehydrating breathers MTraB®
- Pressure relief valves MPreC®
- Sensors, accessories
- Thermometers MDiT®, SMART VT
- Smart Grid Solutions

**Automation & Control**
- Voltage regulator TAPCON®
- Monitoring systems TAPGUARD®

**Asset Management Solutions**
- On-load tap-changer service and support
  - Training
  - Spare parts
  - Retrofit solutions for all products

**Power Composites**
- Composite hollow isolators ReCoTec®
- Glass fiber reinforced plastic (GFRP) tubes ROTAFIL®

**Power Quality**
- Compensation systems for all voltage levels
  - Components, network studies