Medium-voltage switchgear

GMA

Gas-insulated switchgear up to 24 kV - 2500 A - 31.5 kA

Operation - Maintenance
Technical Manual

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Remarks on this manual

As our products are subject to continuous further development, we reserve the right to make changes regarding standards, illustrations and technical data. All dimensions specified in this manual are in millimeters.

Purpose and target group

This Technical Manual describes operation and maintenance of gas-insulated medium-voltage switchgear units of the GMA series. It is exclusively intended for use by the manufacturer’s staff or by persons certified for the GMA series (training certificate).

The work described in this manual may only be performed by specialist electricians with proven experience in conjunction with:

- the GMA series (training certificate)
- all relevant safety provisions.

This Technical Manual is an integral part of the product and must be stored so that it is readily accessible at all times for and can be used by persons who are to work on the switchgear. If the switchgear is relocated to another site, this Technical Manual must be passed on to the new operators along with the unit.

This Technical Manual cannot describe every imaginable individual case or every customer-specific version of the product. For information which is not included in this manual, please contact the manufacturer.

Reference documents

The following additional documents must be complied with:

- purchase agreement with the stipulations regarding the switchgear-specific equipment and the legal details
- the appropriate switchgear-specific circuit diagrams / documentation
- GMA Assembly Instructions
- the Operating Manuals of the devices installed in the switchgear:
  - Voltage detection systems, e. g. IVIS (no. AGS 531 751-01)
  - System for the detection of internal arcs ILIS (optional) (no. AGS 531 761-01)
  - devices in the low-voltage cabinet
Remarks on this manual

Terms and symbols used

This Technical Manual uses certain terms and symbols. They warn about dangers or provide important information which must be complied with in order to avoid danger to persons and damage to equipment:

“Danger!”
This danger symbol warns about dangerous electrical voltage. Contact with voltage may result in fatal injury!

“Warning!”
This danger symbol warns about the risk of injury. Please comply with all the provisions identified by this symbol in order to avoid death or serious injury.

“Notice:”
This instruction symbol is used for information which is important to avoid material damage.

Abbreviations used

$U_r$: Rated voltage

$I_r$: Rated current

Any questions or suggestions?

Do you have any questions or suggestions regarding this manual, or do you require further information?

We always strive to provide you with the best-possible information for optimum, safe use of our products. Thus, do not hesitate to contact us if you have any recommendations, amendments or proposals for improvement.
1 Safety provisions

The work described in this manual may only be performed by specialist electricians with proven experience in conjunction with the GMA series and the applicable safety provisions.

Please read the whole manual carefully before working on the switchgear.

Applicable standards and regulations:

- Metal-enclosed AC switchgear for rated voltages > 1 kV up to including 52 kV: IEC 62271-200
- Use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear: IEC 62271-303
- The locally applicable accident prevention, operating and work instructions must be complied with.
- Installation: IEC 61936-1/EN 50522¹
- Operation of electrical equipment: EN 50110-1²

¹ The national standards applicable in the country where the equipment is to be installed must be complied with.

Before performing work on the panel, it is essential that you comply with the following instructions:

Danger!
Risk of fatalities due to high voltage. Isolation from high voltage and earthing must always be ensured before performing assembly or maintenance work.

Danger!
Risk of fatalities due to supply voltage. Isolation from supply voltage must always be ensured before performing assembly or maintenance work.

Warning!
Risk of injury due to movable parts in mechanical drives. For maintenance work,
- isolate the system from the supply voltage
- release the circuit-breaker’s energy storing device by OFF-ON-OFF operation.

Warning!
After removing covers from a switchgear unit, operator safety may be reduced regarding internal arcs unless the switchgear is isolated from the power supply. Optimum operator safety is only ensured if the switchgear is completely disconnected from the power supply and grounded during assembly.

5 Safety rules

1. Isolate from the power supply,
2. make sure that unintentional restart (reclosure) is prevented,
3. verify zero voltage,
4. earth and short-circuit,
5. cover or cordon off adjacent live components.

Behaviour in case of incidents or accidents

For the case of an internal fault, the GMA switchgear features pressure relief ports which prevent the panels and the switchgear from bursting.

This Technical Manual does not include information regarding the safety of buildings in case of internal faults (pressure load of the switchgear room and necessary pressure relief ports). Pressure calculations for switchgear rooms incl. recommendations regarding pressure relief ports can be provided on request against a fee. For further details, please contact the manufacturer.

In case of fire or of internal faults, toxic and caustic decomposition products may be produced. Comply with the locally applicable accident and safety provisions.

In case of personal injury, take first-aid measures or cause them to be taken.
2.1 Panel variants GMA

The illustrations show the panel types with their respective basic equipment without pressure relief duct. Customized models or additional equipment are described in the switchgear-specific documentation.

Fig. 1
Circuit-breaker panel GMA with outer cone-type bushing
1. Low-voltage cabinet
2. Control unit "GemControl" including insulation gas monitoring
3. Protection unit, e. g. "Micom"
4. Socket-contacts for voltage detection systems (optional "IVIS" system)
5. Manual operator interface
6. Cable compartment cover
7. High-voltage cable connection on the standardized outer cone-type connection system
8. Earth bus
9. Illustrated: Voltage transformer on cable connection (optional voltage transformer on busbar available)
10. Current transformer
11. Disconnecting device for the voltage transformer
12. Vacuum circuit-breaker
13. 3-position switch (disconnecting and earthing switch)
14. Busbar system
2 Design and description

Fig. 2
Incoming feeder panel with circuit-breaker, voltage transformer and double cable connection
1 Low-voltage cabinet
2 Control unit "GemControl" including insulation gas monitoring
3 Protection unit, e. g. "Micom"
4 Socket-contacts for voltage detection systems (optional "IVIS" system)
5 Manual operator interface
6 Cable compartment cover
7 High-voltage cable connection on the standardized outer cone-type double connection system
8 Earth bus
9 Illustrated: Voltage transformer on cable connection (optional voltage transformer on busbar available)
10 Current transformer
11 Tank with vacuum circuit-breaker and 3-position switch (disconnecting and earthing switch)
12 Busbar system
Busbar coupler

Fig. 3
Bus section coupler panel
1 Low-voltage cabinet
2 Control unit "GemControl" including insulation gas monitoring
3 Manual operator interface
4 Front cover
2  Design and description

2.2  Applicable standards

Series GMA switchgear units are

- metal-enclosed
- SF6-insulated
- type-tested and prefabricated
- tested for internal faults (qualification IAC)
- dimensioned for indoor installation

GMA switchgear units meet the following standards and regulations:

<table>
<thead>
<tr>
<th>Designation</th>
<th>IEC standard</th>
<th>EN standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear</td>
<td>IEC 62271-200</td>
<td>EN 62271-200</td>
</tr>
<tr>
<td></td>
<td>IEC 62271-1</td>
<td>EN 62271-1</td>
</tr>
<tr>
<td>Internal arc classification (IAC)</td>
<td>IEC 62271-200</td>
<td>EN 62271-200</td>
</tr>
<tr>
<td>Circuit-breaker</td>
<td>IEC 62271-100</td>
<td>EN 62271-100</td>
</tr>
<tr>
<td>Earthing switch</td>
<td>IEC 62271-102</td>
<td>EN 62271-102</td>
</tr>
<tr>
<td>Disconnector</td>
<td>IEC 62271-102</td>
<td>EN 62271-102</td>
</tr>
<tr>
<td>Current transformer</td>
<td>IEC 60044-1</td>
<td>EN 60044-1</td>
</tr>
<tr>
<td>Voltage transformer</td>
<td>IEC 60044-2</td>
<td>EN 60044-2</td>
</tr>
<tr>
<td>Voltage detecting systems</td>
<td>IEC 61243-5</td>
<td>EN 61243-5</td>
</tr>
<tr>
<td>Protection against accidental contact, foreign bodies and water</td>
<td>IEC 60529</td>
<td>EN 60529</td>
</tr>
<tr>
<td>Installation</td>
<td>IEC 61936-1</td>
<td>EN 61936-1</td>
</tr>
<tr>
<td>Operation of electrical equipment</td>
<td>–</td>
<td>EN 50110-1</td>
</tr>
<tr>
<td>Insulation gas sulphur hexafluoride SF6</td>
<td>IEC 60376</td>
<td>EN 60376</td>
</tr>
<tr>
<td>Use and handling of sulphur hexafluoride (SF6)</td>
<td>IEC 62271-303</td>
<td>–</td>
</tr>
</tbody>
</table>

**Degrees of protection against accidental contact and foreign objects**

<table>
<thead>
<tr>
<th>Degrees of protection against accidental contact and foreign objects according to IEC 60529</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main electric circuits</td>
</tr>
<tr>
<td>Drive mechanisms</td>
</tr>
<tr>
<td>Low-voltage cabinet</td>
</tr>
<tr>
<td>Cable compartment</td>
</tr>
</tbody>
</table>

¹ optional IP5X

2.3  Environmental and operating conditions

GMA is an indoor switchgear and may only be operated under normal conditions in acc. with IEC 62271-1.

**Ambient conditions (in accordance with IEC 62271-1)**

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>°C</th>
<th>Min./max. ambient temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. 10%</td>
<td>–5/+40¹</td>
<td></td>
</tr>
<tr>
<td>Max. 10%</td>
<td>–5/+35</td>
<td></td>
</tr>
</tbody>
</table>

¹ other values available on request

Operation under conditions deviating from these is only admissible subject to consultation with and written approval from the manufacturer.
2.4 Ratings of the GMA series

The maximum admissible ratings depend on the ambient conditions, the switchgear design and the internal fault qualification (IAC) (see also Switchgear Configuration). Thus, the ratings might be restricted.
For further details, please contact the manufacturer.

The admissible ratings for a panel are always specified on the appropriate name-plate of the panel (Fig. 4, page 13).

<table>
<thead>
<tr>
<th>Rated voltage $U_r$ [kV]</th>
<th>12</th>
<th>17.5</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated lightning impulse withstand voltage $U_p$ [kV]</td>
<td>75</td>
<td>95</td>
<td>125</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage $U_d$ [kV]</td>
<td>28</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>Rated normal current, busbar $I_r$ [A]</td>
<td>≤ 2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated normal current, feeder panel $I_r$ [A]</td>
<td>≤ 2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated peak withstand current $I_p$ [kA]</td>
<td>≤ 63/80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated short-circuit breaking current $I_{sc}$ [kA]</td>
<td>≤ 31.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated short-time current $I_k$ (3 s) [kA]</td>
<td>≤ 31.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated frequency $f_r$ [Hz]</td>
<td>50/60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 Design and description

2.5 Nameplate

The type designation of the switchgear panels on the nameplate (Fig. 4) specifies the essential technical data. When submitting enquiries to the manufacturer or when ordering spare parts, the following information is required:

- Type designation
- Serial number
- Year of construction

The following example shows the composition of the type designation (Fig. 4, item 1):

Example

<table>
<thead>
<tr>
<th>Series GMA</th>
<th>GMA 17 - 31 - 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>17.5 kV</td>
</tr>
<tr>
<td>Rated short-time current</td>
<td>31.5 kA/3s</td>
</tr>
<tr>
<td>Width of panel</td>
<td>600 mm</td>
</tr>
</tbody>
</table>
Design and description

2.6 Technical data of electrical control and operating devices

Description of the drives

The mechanical drive with its integrated mechanical interlocks and electrical operating equipment features a modular design. This permits straightforward access to all components installed with just a few operations. Disconnectors and earthing switches are designed as 3-position switches. The circuit-breaker is equipped with a spring energy store which ensures quick operating sequences and an auto-reclosing feature. The individual switching device drive mechanisms can be completely automated and remote-controlled. Three separate permanent magnet motors are used for automation:
- on the circuit-breaker to charge the switching spring
- on the disconnector for direct switching ON and OFF
- and on the earthing switch for direct switching ON and OFF.

The drive mechanism is equipped with the mechanical “Earthing switch intertripping circuit” as special feature. Here, the circuit-breaker is actuated automatically during mechanical or electrical operation of the earthing switch, so that the switching operation “Earthing” requires a single operation only. Here, it is important that at the same time, accidental opening of the circuit-breaker is prevented mechanically in earthed condition. Mechanical interlocks can be replaced by electrical interlocks, in order to enable free electrical interlocking.

Structural view of drive mechanisms

![Structural view of drive mechanisms](image)

Fig. 5
Modular design of the drives and item of apparatus code
1 Disconnector (-Q1)
2 Circuit-breaker (-Q0)
3 Earthing switch (-Q8)

Electrical equipment:

The electrical operating equipment within the mechanical drive is used according to the rated supply voltage available.

Overview of rated supply voltages

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>[V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct voltage DC</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>220</td>
</tr>
<tr>
<td>Alternating voltage AC</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>230</td>
</tr>
</tbody>
</table>
2 Design and description

Electrical operating equipment on the circuit-breaker

- Motor drive on the circuit-breaker (-Q0-M11), permanent magnet motor, power consumption 200 W
  The motor drive charges the energy-storing device (spring)
- 1st shunt opening release (-Q0-F11), power consumption 160 W
- Optional: 2nd shunt opening release (-Q0-F12), power consumption 160 W
  Shunt opening releases switch the circuit-breaker OFF and follow the open-circuit principle
- Shunt-closing release (-Q0-F21)
  The shunt closing release switches the circuit-breaker ON and follows the open-circuit principle.
- Undervoltage release (-Q0-F13), power consumption 12 W (optional)
  The undervoltage release switches the circuit-breaker OFF in de-energized condition (control voltage) and follows the closed-circuit principle.

Alternative to Q0-F13:
- Optional: a transformer-operated release / secondary release (-Q0-F14), power consumption 0.3 W (12VDC)
  The transformer-operated release / secondary release switches the circuit-breaker OFF using the power of a current transformer.
  (-F14 has been designed for the MiCOM protection relays P115 and P116)

Fig. 6
Overview of electrical operating equipment
1 Transformer-operated release / secondary release -Q0-F13 or
2 Alternatively: module with transformer-operated release / secondary release -Q0-F14
3 Motor -Q0-M11
4 Shunt opening release -Q0-F11, -F12, shunt closing release -F21
## Design and description

### Power consumption, solenoids

<table>
<thead>
<tr>
<th>Release Type</th>
<th>DC 24</th>
<th>DC 48</th>
<th>DC 60</th>
<th>DC 110</th>
<th>DC 125</th>
<th>DC 220</th>
<th>AC 120</th>
<th>AC 230</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shunt-closing release (-Q0-F21)</td>
<td>160 W</td>
<td>160 VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt opening release (-Q0-F11, -Q0-F12)</td>
<td>160 W</td>
<td>160 VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undervoltage release (-F13)</td>
<td>12 W</td>
<td>12 VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary transformer-operated release (-F14)</td>
<td>0.3 W, 12 VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocking coils (-Q0-Y2,-Q0-Y3,-Q1-Y1, -Q8-Y1,-Q11-Y1,-Q12-Y1,-Q15-Y1,-Q16-Y1)</td>
<td>10.2 W</td>
<td>10.2 VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Voltage limit ranges within which the releases work reliably

<table>
<thead>
<tr>
<th>Release Type</th>
<th>Direct voltage</th>
<th>Alternating voltage, 50/60Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shunt opening release without/with auxiliary spring energy store</td>
<td>70 to 110 % Un</td>
<td>85 to 110 % Un</td>
</tr>
<tr>
<td>Shunt closing release</td>
<td>85 to 110 % Un</td>
<td></td>
</tr>
<tr>
<td>Undervoltage release</td>
<td>Automatic opening</td>
<td>&lt; 35 % [Un]</td>
</tr>
<tr>
<td></td>
<td>No automatic opening</td>
<td>&lt; 70 % [Un]</td>
</tr>
<tr>
<td></td>
<td>Closing possible</td>
<td>≥ 85 % [Un]</td>
</tr>
<tr>
<td></td>
<td>Closing not possible</td>
<td>&lt; 35% [Un]</td>
</tr>
</tbody>
</table>

### Times for releases and motors

- Minimum command time "OFF" el. tripping [V] [ms] 20
- Minimum command time "ON" el. tripping [V] [ms] 20
- Motor charging time for circuit-breaker, spring mechanism [s] approx. 7

### Technical data of auxiliary switches

<table>
<thead>
<tr>
<th>Rated supply voltages of drive [V]</th>
<th>DC 24</th>
<th>DC 48</th>
<th>DC 60</th>
<th>DC 110</th>
<th>DC 125</th>
<th>DC 220</th>
<th>AC 120</th>
<th>AC 230</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching capacity [A]</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1.7</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Time constant T=L/R [ms]</td>
<td>≤ 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated short-time current</td>
<td>100 A for a duration of 30 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated continuous current [A]</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum switching capacity</td>
<td>24 [V]; 15 [mA]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 Design and description

Power consumption and protection of motors - disconnectors, earthing switches and circuit-breakers

<table>
<thead>
<tr>
<th>Rated voltage of drive [V]</th>
<th>DC 24</th>
<th>48</th>
<th>60</th>
<th>110</th>
<th>125</th>
<th>220</th>
<th>120</th>
<th>230</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 W</td>
<td></td>
<td></td>
<td>200 VA</td>
<td></td>
</tr>
</tbody>
</table>

Suitable automatic circuit-breaker (tripping characteristic / nominal current)

- C 4A
- C 2A
- C 3A
- C 1A
- C 0.5A

Blocking coils on circuit-breaker

- Optional: Blocking coil on ON pushbutton (-Q0-Y2)
  - Power consumption 10.2 W
  - In deenergized condition, the blocking coil blocks the mechanical ON pushbutton.

- Optional: Blocking coil on OFF pushbutton (-Q0-Y3)
  - Power consumption 10.2 W
  - In deenergized condition, the blocking coil blocks the mechanical OFF pushbutton.

Fig. 7
Overview of blocking coils
1. Blocking coils -Q0-Y2 and -Y3
2. Disassembled pushbutton module

Direct access to the blocking coils -Y2 and -Y3 is possible by releasing the pushbutton module which is secured by means of three screws.
Auxiliary switches and auxiliary contacts on circuit-breaker

Auxiliary switches for indication of switch positions are always actuated directly by the switch shaft via an intermediate linkage. Their position always corresponds to that of the main contacts of the circuit-breaker. The switching functions have been designed in the factory according to the circuit diagram.

- Auxiliary switch, switch position, 18 contact elements (-Q0-S011)
- Auxiliary contact on energy store mechanism for motor control, 4 contact elements (-Q0-S021).

The auxiliary switch on the energy-storing device is actuated with the spring of the energy-storing device charged.

- 1st auxiliary contact on the ON/OFF pushbutton (-Q0-S041).
- 2nd auxiliary contact on the ON/OFF pushbutton (-Q0-S042).
- 3rd auxiliary contact on the ON/OFF pushbutton (-Q0-S045).

The auxiliary contacts on the mechanical ON/OFF pushbutton are actuated via the two pushbuttons.

- Auxiliary contact on the OFF pushbutton (-Q0-S043).

The auxiliary contact on the mechanical OFF pushbutton is actuated by the OFF push-button. The auxiliary contact prevents electrical closing in case of mechanically actuated OFF.

Special auxiliary contacts

- Auxiliary contact on the mechanical lock-out (-S044, optional).

The auxiliary contact (NO contact) is actuated if the crank insertion opening “Disconnector/earthing switch” and/or the pushbutton for the circuit-breaker is locked mechanically via the key switch.

- Auxiliary contact on the cable compartment cover interlock (-S046, optional).

Auxiliary contact (NC contact) on interlock of cable compartment cover is actuated when cable compartment cover is unlocked or has been removed.

Fig. 8
Overview of auxiliary switches
1 Auxiliary switches -Q0-S011
2 Auxiliary contacts -Q0-S041,-S042,-S043
3 Auxiliary switch block -Q0-S021 and -S022
2 Design and description

Electrical operating equipment for disconnectors and earthing switches

- Motor on disconnector (-Q1-M11)
  Permanent magnet motor, power consumption 200 W
  The motor drive switches the disconnector ON and OFF (left-hand/right-hand rotation).

- Auxiliary switch, switch position, 14 contact elements (-Q1-S011)
  Auxiliary switch depending on the position of the main contacts of the disconnector.

- Blocking coil insertion opening (-Q1-Y1)
  Power consumption 10.2 W (optional)
  In deenergized condition, blocking coil blocks the insertion opening for the mechanical disconnector drive mechanism.

- Motor on earthing switch (-Q8-M11)
  Permanent magnet motor, power consumption 200 W
  The motor drive switches the earthing switch ON and OFF (left-hand/right-hand rotation).

- Auxiliary switch, switch position, 14 contact elements (-Q8-S011)
  Auxiliary switch depending on the position of the main contacts of the earthing switch.

- Optional: Blocking coil insertion opening (-Q8-Y1)
  Power consumption 10.2 W
  In deenergized condition, blocking coil blocks the insertion opening for the mechanical earthing switch drive mechanism.

- Optional: 1st auxiliary contact on the interrogating device for the disconnector / earthing switch (-S151)
  Auxiliary contact on the mechanical interrogating device for the disconnector / earthing switch. The auxiliary contact is actuated if the crank insertion opening of the disconnector or of the earthing switch is open.

- Optional: 2nd auxiliary contact on the interrogating device for the disconnector / earthing switch (-S152 – description as above).

![Fig. 9 Disconnector and earthing switch](image-url)

1. Auxiliary switches -Q1-S011, -Q8-S011
2. Motor -Q1-M11,-Q8-M11
3. Blocking coil -Q1-Y1,-Q8-Y1
4. Attachment auxiliary contact -S151,-S152
2 Design and description

2.7 Intended use

Gas-insulated GMA medium-voltage switchgear units are exclusively intended for switching and distributing electrical energies. They may only be used in the scope of the specified standards and the switchgear-specific technical data. Any other utilization constitutes improper use and may result in dangers and damage.

Liability Disclaimers

The manufacturer shall not be held responsible for damage which occurs if

- instructions in this Technical Manual are not complied with;
- the switchgear is not operated according to its intended use (see above);
- the switchgear is assembled, connected or operated improperly;
- accessories or spare parts are used which have not been approved by the manufacturer;
- the switchgear is converted without the manufacturer’s approval, or if inadmissible parts are added.

No liability is accepted for parts provided by customers, e.g. current or voltage transformers.

2.8 Disposal after the end of service life

The operating equipment contains the fluorinated greenhouse gas SF₆ covered by the Kyoto Protocol with a global warming potential (GWP) of 22 200.

SF₆ must be recovered and must not be released into the atmosphere. When transporting and handling SF₆, the specifications in IEC 62271 High-Voltage Switchgear and Controlgear – Part 303 Use and Handling of Sulphur Hexafluoride (SF₆), must be complied with.

A material and recycling data sheet can be provided on request for the disposal of series GMA switchgear units at the end of their service life.

Disposal is performed as a service by the manufacturer’s Service Center and is subject to a fee.
3 Insulation gas monitoring system

3.1 Technical Data

Insulation gas

Type of insulation gas: Sulphur hexafluoride SF₆ according to IEC 60376.

"Sealed Pressure System"

The tanks of the switchgear have been designed as "Sealed Pressure System" as defined by the publication IEC 62271-200. Thanks to the design of the "Sealed Pressure System", the insulation gas contents do not require any maintenance. During the expected useful life, no insulation gas has to be replenished under normal operating conditions acc. to IEC 62271-1.

Properties of insulation gas monitoring:
- temperature-compensated and continuously active during operation
- independent of the installation height
- indicated simply on the switchgear front and equipped with remote-signalling contacts on request.

Gas compartment technology

Standard series GMA switchgear units consist of individual panels according to the variants described in Chapter 2. Each single panel has an insulation gas tank in which all high-voltage switching devices are integrated. Moreover, each insulation gas tank is completely autonomous and features all the monitoring and function elements necessary for gas compartment management (Fig. 10).
- Self-closing gas connection valve
- Insulation gas monitoring system
- Pressure relief device.

Pressure relief device

In case of excess pressure, pressure relief is effected in the rear panel area. The pressure relief area is metallically separated from the cable connection area. An additional panel pressure relief duct is optionally available.

Self-closing gas connection valve:
- Systems for insulation gas monitoring are connected to the self-closing gas connection valve.
- At the end of a panel's service life, suitable disposal equipment can be connected; see also IEC62271-303.

Insulation gas monitoring systems:
- temperature-compensated pressure gauge, see Chapter 3.3 or
gas density switch in conjunction with the control unit "Gem Control", see Chapter 3.4.

Rated pressure and insulation gas monitoring warning levels

<table>
<thead>
<tr>
<th>Rated pressure and insulation gas monitoring warning levels</th>
<th>Rated pressure $p_{re}$</th>
<th>MPa</th>
<th>$0.03^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st warning level in case of pressure drop $p_{ae}$ (= Minimum service pressure $p_{me}$)</td>
<td>MPa</td>
<td>$0.02^1$</td>
<td></td>
</tr>
<tr>
<td>2nd warning level in case of pressure drop</td>
<td>MPa</td>
<td>$0.01^1$</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ The pressure data refers to $+20^\circ\text{C}$ and an atmospheric pressure of 101.3 kPa abs.

The rated pressure ($p_{re}$), the minimum service pressure ($p_{me}$) and the first alarm level ($p_{ae}$) are always specified on the appropriate nameplate of the panel.

Fig. 10
Gas compartment diagram
1 Self-closing gas connection valve
2 Insulation gas monitoring system
3 Gas compartment
4 Pressure relief device
### 3.2 Measures to be taken at the various warning thresholds

<table>
<thead>
<tr>
<th>Meaning</th>
<th>Status of remote signalling relays</th>
<th>Dielectric strength of compartment</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>ready for operation</td>
<td>Both remote signalling relays picked up</td>
<td>The insulating level corresponds to the data on the nameplate</td>
<td>_</td>
</tr>
</tbody>
</table>
| 1st warning level in case of pressure drop | remote signalling relay, "1st warning level" dropped, "2nd warning level" remains picked-up | When the light for the 1st warning level goes on, the insulating level corresponds to the data of the nameplate; beyond this, the insulating level might be reduced. | ▪ Contact Service-Center  
▪ Replenish insulating gas  
▪ Plan ahead for shut-off |
| 2nd warning level in case of pressure drop | remote signalling relay "2nd warning level" dropped, "1st warning level" is not picked up | The insulating level is limited. | ▪ Contact Service-Center  
▪ De-energize compartment |

1 Insulation gas may only be replenished by trained specialist staff. Refer to the applicable safety provisions and data sheets. For use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear, IEC 62271-303 must be complied with.

### 3.3 Pressure gauges

The pressure gauge indication is ambient temperature-compensated. The pressure indication remains constant if the operating mode remains unchanged, even if the temperature in the switchgear room changes.

**Variants**

- Pressure gauge without remote signalling contacts (Fig. 11)
- Pressure gauge with remote signalling contacts (Fig. 12)

<table>
<thead>
<tr>
<th>Electrical signalling contact</th>
<th>Switching function: closes in case of a drop in pressure, if</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>... 1st warning level is reached</td>
</tr>
<tr>
<td>2</td>
<td>... 2nd warning level is reached</td>
</tr>
</tbody>
</table>

![Fig. 11](image1.png)  
Pressure gauge without remote signalling contacts  
1 Pointer  
2 Pointer in the green area (ready for operation)  
3 Pointer in the yellow area (1st warning level)  
4 Pointer in the red area (2nd warning level)

![Fig. 12](image2.png)  
Pressure gauge with remote signalling contacts  
1 Pointer  
2 Pointer in the green area (ready for operation)  
3 Pointer in the yellow area (1st warning level)  
4 Pointer in the red area (2nd warning level)
3 Insulation gas monitoring system

3.4 Gas density switch and indication in GemControl

The gas density switch is firmly screw-fastened to the self-closing gas connection valve of the insulation gas tank (Fig. 13). It can be replaced at any time, as required. The gas density switches are temperature-compensated. If the insulation gas temperature changes, the signal remains constant, as the insulation gas density does not change.

The gas density switch has two NO contacts. The NO contacts define two response thresholds which transmit three differentiated messages to the GemControl display unit, according to the operating status (Fig. 14).

Components and functions of insulation gas monitoring

Fig. 13
1 Gas density switch
2 Connection cable to display unit
3 Cap nut
4 Self-closing gas connection valve

Fig. 14
1 Control unit "GemControl"
2 Gas density switch
3 Gas compartment
4 Voltage Detecting Systems (VDS)

4.1 Pluggable voltage detecting system

The system voltage or the zero voltage state of the outgoing feeders is detected via a separate voltage detection system according to IEC 61243-5. Socket-contacts for the indicators are located in the instrument-recess below the low-voltage cabinet. Capacitive voltage presence indicating systems of all the approved manufacturers can be used.

**Notice:**
- Comply with the manufacturer's Operating Manual of the voltage indicators used.
- All three phases L1, L2 and L3 must always be checked together.

Close non-used socket-contacts using a cap.

![Voltage indicator unit (HR-ST)](image1)

Fig. 15 Voltage indicator unit (HR-ST) Horstmann GmbH

![Socket-contacts for HR system](image2)

Fig. 16 Socket-contacts for HR system

4.2 Integrated Voltage Detecting System IVIS

IVIS is an integrated voltage detecting system with an integrated display unit used to determine zero voltage/system voltage according to IEC 61243-5. The IVIS system has been designed for maximum operating reliability. It does not require supply from an external source. It features climate-proof encapsulated electronics and is maintenance-free due to permanent monitoring of the indication thresholds.

Flash arrow symbols on the indicators display the mains voltage still existing within the defined response thresholds (Fig. 17). The IVIS system does not require the electrical repeat tests common for voltage detecting systems.

**Notice:**
For a description of all functions and messages of the IVIS system, please refer to the separate Operating Manual "IVIS" (No. AGS 531 751-01).
4.3 Phase comparators

Notice:
Before connecting live switchgear components for the first time, always check phase coincidence.

If IVIS is used, phase comparison can be performed by means of the phase comparator DEHNcap/PC-LRM (Fig. 18, ref. no. AGS C26320-01). Phase comparators are optionally available and not included in the scope of supplies.

Fig. 18
Phase comparator DEHNcap / PC-LRM
5.1 Operator interfaces for manual operation

For control of the panels of the GMA series, two different control concepts are on principle available.

Control concept variants:

- Panels with mechanical interlocking of the switching devices
  
  Manual operation of the switching devices dominates control and interlocking conditions.
  
  - For complete manual operation of all the switching devices installed, including logistic, intra-panel, mechanical interlocks for switchgear interlocking, refer to Chapter 5.5.1
  
  - Optional motor drive for the disconnector
  
  - Optional additional cylinder lock mechanism for the switching devices.
  
  - Both conventional and electrical control of motorized switching devices possible. The I&C system must correspond to the mechanical interlock.

- Panels with electronic interlocking of the switching devices via I&C
  
  Remote operation of the switching devices via I&C determines the control and interlocking conditions.
  
  - Disconnectors and earthing switches are designed with motor drive and are on principle controlled electrically.
  
  - Manual emergency mode available for all switching devices
  
  - No integrated, mechanical interlocking protection!
  
  - Cylinder lock mechanism mandatory for manual emergency mode (standard)
5 Operation

Feeder / outgoing feeder panel

Bus riser panel

Bus riser panel with disconnector and earthing switch (optional), without circuit-breaker. For design and description of the control elements and indicators, please refer to Fig. 21.
Operation

Bus section coupler with earthing switch

The bus section coupler panel is used to connect various busbar sections. Panel design with
- circuit-breaker, disconnector and earthing switch, and
- bus riser with disconnector and earthing switch

Fig. 23
Bus section coupler
1 Position indicator of left-hand earthing switch
2 Insertion opening for actuation of left-hand earthing switch
3 Interrogation slide for the left-hand disconnector and the earthing switch (is only provided in case of mechanical interlocking of switching devices)
4 Insertion opening for actuation of the left-hand disconnector
5 Position indicator of left-hand disconnector
6 Mechanical lock-out with cylinder lock
   Interlocking of switching devices
   - mechanical: optionally available
   - via I&C: standard
7 Pushbutton, circuit-breaker ON
8 Pushbutton, circuit-breaker OFF
9 Circuit-breaker position indicator
10 Status indicator for spring mechanism released/charged
11 Operations counter, circuit-breaker
12 Insertion opening for manual charging of the circuit-breaker's spring mechanism
13 Nameplate
14 Position indicator of right-hand earthing switch
15 Insertion opening for actuation of right-hand earthing switch
16 Position indicator of right-hand disconnector
17 Insertion opening for actuation of right-hand disconnector
18 Interrogation slide for the right-hand disconnector and earthing switch (is only provided in case of mechanical interlocking of switching devices)
5.2 Interlocks

**Warning!**
Danger in case of faulty operation of the switchgear! Complete switchgear interlocking can only be ensured with complete locking devices.

**Notice:**
Please note the switchgear-specific circuit diagrams/documentation as regards the design of the interlocking systematics.

### 5.2.1 Internal mechanical interlocks of the panel
- With the circuit-breaker closed, the interrogation slide for the disconnector and earthing switch is locked.
- The interrogation slide always releases one insertion opening (disconnector or earthing switch), or both of them are locked.
- The crank for the disconnector and earthing switch can only be removed in its appropriate end position.
- The earthing switch can only be switched ON with the circuit-breaker’s spring mechanism charged (intertripping circuit of circuit-breaker during earthing, see chapter 5.4, page 35).
- If the crank on the disconnector or earthing switch has not been removed, or if the interrogation slide is open, the following components are locked
  - ON/OFF pushbutton of circuit-breaker
  - ON/OFF pulse is interrupted
  - Motor drive (optionally only possible on disconnector)
- In panels with two interrogation slides (bus section coupler), the following items are locked:
  - Both interrogation slides cannot be opened simultaneously.
  - The interrogation slides are blocked depending on the position of the disconnector or earthing switch (see interlock tables as of page 33).

### 5.2.2 Mechanical lock-out mechanisms with U lock (optional)
On request, circuit breakers, disconnecters and earthing switches can be equipped with padlocks to prevent mechanical actuation (Fig. 24). U locks are not included in the scope of supplies provided by the factory.

**Fig. 24**
1. Interlock flaps for ON/OFF pushbutton
2. Insertion opening for disconnector and earthing switch blocked
5.2.3 Mechanical lock-out with cylinder lock for panels with mechanical interlocking of the switching devices (optional)

An additional cylinder lock mechanism (Fig. 25) can be installed optionally for the disconnector and earthing switch and the ON pushbutton of the circuit-breaker. The OFF pushbutton can also integrated, if required, in the cylinder lock mechanism. The cylinder lock mechanism locks the interrogation slide (1) and the pushbuttons (4).

Interlock operation:

<table>
<thead>
<tr>
<th>Key position and sense of rotation</th>
<th>Actuation of disconnector and earthing switch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>manual (interrogation slide)</td>
</tr>
<tr>
<td>removable</td>
<td>blocked</td>
</tr>
<tr>
<td>not removable</td>
<td>free</td>
</tr>
<tr>
<td>cannot be turned and not removed</td>
<td>opened</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>electrical (motor-operated drive mechanism)</th>
</tr>
</thead>
<tbody>
<tr>
<td>removable blocked</td>
<td>free</td>
</tr>
<tr>
<td>not removable free</td>
<td>blocked</td>
</tr>
<tr>
<td>opened blocked</td>
<td>blocked</td>
</tr>
</tbody>
</table>
5.2.4  Mechanical lock-out with cylinder lock for panels without mechanical interlocking of the switching devices

Panels which are locked electronically via I&C and not equipped with an integrated, mechanical interlock feature a cylinder lock mechanism (Fig. 26).

**Warning!**

Risk due to faulty operation of switching devices. If the cylinder lock mechanism is deactivated, there is no switchgear interlocking! Switching operations without interlock may only be performed by authorized staff.

The cylinder lock mechanism locks
- the insertion openings for the disconnector (Fig. 26, item 2)
- the insertion openings for the earthing switch (item 1) and
- the ON pushbutton (item 5).

The OFF pushbutton (item 6) can also be integrated, if required, in the cylinder lock mechanism.

A sign (item 3) indicates that no interlocks are active during manual operation!

**Interlock operation:**

<table>
<thead>
<tr>
<th>Key position and sense of rotation</th>
<th>Actuation of disconnector and earthing switch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>manual (insertion opening)</td>
</tr>
<tr>
<td>removable</td>
<td>blocked</td>
</tr>
<tr>
<td>not removable</td>
<td>free</td>
</tr>
<tr>
<td>cannot be turned and cannot be removed</td>
<td>free and crank inserted</td>
</tr>
</tbody>
</table>

Fig. 26
1  Insertion opening for earthing switch
2  Insertion opening for disconnector
3  Information sign
4  Mechanical lock-out with cylinder lock
5  ON pushbutton of circuit-breaker
6  OFF pushbutton of circuit-breaker
5.2.5 Electromagnetic interlocks (optional)

Electromagnetic blocking coils can be used both for inter-panel and intra-panel interlocks:

- The actuating ports for disconnector and earthing switch via the interrogation slide are prevented from being released;
- The circuit-breaker's ON and OFF pushbuttons are blocked.

**Notice:**
- In case of failure of the supply voltage, all electrical interlocks are in their "locked" position. Measure: Re-establish power supply.
- Please comply with the switchgear-specific circuit diagram as regards the design of the interlocking systematics.
- If no blocking coils are being used for the locking devices, a mechanical lock-out with cylinder or U lock must be provided (see Chapters 5.2.3 and 5.2.2 on page 29).

### Blocking coil required, if...

<table>
<thead>
<tr>
<th>Interlock function</th>
</tr>
</thead>
<tbody>
<tr>
<td>... motor-operated drive on disconnector</td>
</tr>
<tr>
<td>... bus section coupler in switchgear</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Fig. 27**

Blocking coil interlocks in a GMA switchgear unit with bus section coupler

1. Blocking coil on interrogation slide of disconnector in feeder panel
2. Blocking coil on interrogation slide of earthing switches in bus section coupler

---

**Symbol for interlocking via blocking coil**

**Blocking coils for panels with mechanical interlocking of the switching devices**

---
### 5.2.6 Table of mechanical interlock functions of the various panel types

- All in mechanical design
- In case of remote control, the interlocks must be programmed analogously via I&C.

#### Explanations:

- **“–”** no interlock function
- **“blocked”** crank cannot be inserted or pushbutton blocked
- **“uncoupled”** crank can be inserted, but without switching function
- **“free”** operating function released

#### Notice:

**Switchgear with bus section coupler:** Blocking coils are required to ensure continuous interlocking systematics of the mechanical operator interface. Alternatively, lock-outs with cylinder or U lock must be provided.

<table>
<thead>
<tr>
<th>Schematic diagrams of possible switch positions</th>
<th>Circuit-breaker</th>
<th>Pushbutton OFF</th>
<th>Spring mechanism</th>
<th>Disconnector</th>
<th>Interrogation slide</th>
<th>Crank handle</th>
<th>Earthing switch</th>
<th>Interrogation slide</th>
<th>Crank handle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>free</td>
<td>–</td>
<td>–</td>
<td>blocked</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>released</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ON/OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>free</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>–</td>
<td>blocked</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>free</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>decoupled</td>
<td>–</td>
<td>Clockwise rotation blocked</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Operation

### Interlocks in case of bus section couplers within a panel width

- All mechanical for design with "manual drive", except if EM (= blocking coil) is specified explicitly.
- Interlocks for single and double busbars apply analogously also if the left-hand and right-hand busbars are exchanged.
- In case of remote control, the interlocks must be programmed analogously via the bay computer.

**Explanations:**

- "-" no interlock function
- "blocked" crank cannot be inserted or pushbutton blocked
- "uncoupled" crank can be inserted, but without switching function
- "free" operating function released
- "EM" electro-magnetic interlock (blocking coil)

**Notice:**

Blocking coils are required to ensure continuous interlocking systematics of the mechanical operator interface. Alternatively, lock-outs with cylinder or U lock must be provided.

<table>
<thead>
<tr>
<th>Schematic diagrams of possible switch positions</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit-breaker</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Pushbutton OFF</td>
<td>–</td>
<td>free</td>
<td>–</td>
<td>–</td>
<td>blocked</td>
<td>blocked</td>
<td>blocked</td>
<td></td>
</tr>
<tr>
<td>Spring mechanism</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>released</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Disconnector left-hand</td>
<td>OFF</td>
<td>ON/OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Interrogation slide left-hand</td>
<td>free</td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>blocked</td>
<td>blocked</td>
<td>blocked</td>
<td></td>
</tr>
<tr>
<td>Crank handle</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Disconnector right-hand</td>
<td>OFF</td>
<td>ON/OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Interrogation slide right-hand</td>
<td>free</td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>blocked</td>
<td>blocked</td>
<td>blocked</td>
<td></td>
</tr>
<tr>
<td>Crank handle</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Earthing switch left-hand</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Interrogation slide left-hand</td>
<td>free</td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>blocked</td>
<td>blocked</td>
<td>blocked</td>
<td></td>
</tr>
<tr>
<td>Crank handle</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>decoupled</td>
<td>right-hand rotation blocked</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Earthing slide right-hand</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Interrogation slide right-hand</td>
<td>free</td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td>blocked</td>
<td>free</td>
<td>free</td>
<td></td>
</tr>
<tr>
<td>Crank handle</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>right-hand rotation blocked</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
5.3 Operating specifications

The switchgear unit may only be operated by specialist electricians who have proven experience in conjunction with the GMA series and all relevant safety provisions.

**Warning!**
Risk due to faulty operation of switching devices. To rule out faulty switching operations, the operating sequences described below must be complied with. Each switching operation must be completed.

- Check whether the supply voltage is ON.
  While the power supply is not available, blocking coils (locking the interrogation slides and circuit-breaker pushbuttons, depending on design), are in "locked" position.
  An undervoltage release (optional) has dropped out.
  Measure: Re-establish the supply voltage.
- The accessories are supplied together with the panel. Operation of the panel is only admissible if this auxiliary equipment is used (see Chapter 8.2 "Accessories" as of page 52). After each switching operation for which you have used a crank, remove this crank and store it in the tool board.
- Observe the interlocking conditions (Chapter 5.5.6, page 33).

5.4 Operating the circuit-breaker

5.4.1 Charging the circuit-breaker’s energy storing device

**Initial position:**
- Circuit-breaker “OFF”
- Energy storing device "released"

**Charging by means of a motor**

The energy storing device is charged automatically, as soon as the power supply is available.

The position indicator of the energy storing device indicates the "charged" condition (Fig. 28).

**Manual charging**

1. Insert crank.
2. Move crank clockwise until "charged" is indicated by the position indicator.
   If the motor starts during this process, this does not constitute a risk.
3. Remove crank and keep it in a safe place.

![Fig. 28](image-url) Charge the circuit-breaker's energy storing device (closing spring) manually

1. Indication, energy storing device charged
5.4.2 Switching operations on the circuit-breaker

**Switching ON (Closing)**
- Press pushbutton "ON" (Fig. 29) or
- Actuate shunt closing release -Q0-F21 electrically

The energy storing device indicates "released" (1). The position indicated by the switch position indicator is "ON" (2).

*Notice:*
The energy storing device can be charged again immediately (manually) after ON actuation.

When the power supply is ON, the energy storing device is charged automatically via the motor.

**Switching OFF (Opening)**
- Press pushbutton "OFF" (Fig. 30) or
- Actuate shunt opening release -Q0-F11/-Q0-F12 electrically, or
- via secondary release -Q0-F14 or
- via undervoltage release -Q0-F13.

Position indicator indicates the "OFF" position (1).

5.4.3 Position indicators on circuit-breaker and possible operating sequences

<table>
<thead>
<tr>
<th>Item</th>
<th>Position indicator Energy-storing device</th>
<th>Position indicator Circuit-breaker</th>
<th>Possible operating sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>released</td>
<td>OFF</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>charged</td>
<td>OFF</td>
<td>C–O</td>
</tr>
<tr>
<td>3</td>
<td>released</td>
<td>ON</td>
<td>O</td>
</tr>
<tr>
<td>4</td>
<td>charged</td>
<td>ON</td>
<td>O–C–O</td>
</tr>
</tbody>
</table>

C = ON (Close)

O = OFF (Open)
5.5 Operating the disconnector and earthing switch

Notice:
The disconnector and earthing switch drives do not feature stops and can still be turned freely in their end position.

5.5.1 Operating the disconnector manually

The figures and the following description refer to the panel variant with integrated, mechanical interlock of the switching devices and optional cylinder lock. Panels without integrated mechanical interlock of the switching devices do not feature an interrogation interlock (Fig. 31 and Fig. 32, item A). The manual actuating port is enabled or blocked directly via the cylinder lock.

Switching the disconnector ON manually

1. Insert key in cylinder lock (Fig. 31, item C) and unlock the interrogation slide (A).
2. Push interrogation slide (A) to the right to release the insertion opening for the crank.
3. Insert crank (B) and turn it by approx. 10 turns to the right until the position indicator shows that the "ON" position has been reached completely (E).
4. Remove crank. Subsequently, the interrogation slide returns automatically to its central position.

Initial situation:
- Circuit-breaker OFF
- Disconnector OFF
- Earthing switch OFF
- Interrogation slide blocked

Switching the disconnector OFF manually

1. Insert key in cylinder lock (Fig. 32, item C) and unlock the interrogation slide (A).
2. Push interrogation slide (A) to the right to release the insertion opening for the crank.
3. Insert crank (B) and turn it by approx. 10 turns to the left until the position indicator shows that the "OFF" position has been reached completely (E).
4. Remove crank.

Initial situation:
- Circuit-breaker OFF
- Disconnector ON
- Earthing switch OFF
- Interrogation slide blocked

Fig. 31 Switching the disconnector ON manually

Fig. 32 Switching the disconnector OFF manually
5.5.2 Operating the earthing switch manually

Notice:

Intertripping circuit:
The circuit-breaker is switched ON automatically after reaching its earthing position. The OFF actuation of the circuit-breaker is blocked. To switch off, proceed analogously: The circuit-breaker is first switched off automatically.

The figures and the following description refer to the panel variant with integrated, mechanical interlock of the switching devices and optional cylinder lock. Panels without integrated mechanical interlock of the switching devices do not feature an interrogation interlock (Fig. 33 and Fig. 34, item A). The manual actuating port is enabled or blocked directly via the cylinder lock.

Switching the earthing switch ON manually

1. Insert key in cylinder lock (Fig. 33, item C) and unlock the interrogation slide (A).
2. Push interrogation slide (A) to the left to release the insertion opening for the crank.
3. Insert crank and turn it by approx. 10 turns to the right (B) until the position indicators show that the "ON" position of the earthing switch (D) and the circuit-breaker (E) has been reached completely (E). The circuit-breaker is switched ON automatically at last.
4. Remove crank. Subsequently, the interrogation slide returns automatically to its central position.

Switching the earthing switch OFF manually

1. Insert key in cylinder lock (Fig. 34, item C) and unlock the interrogation slide (A).
2. Push interrogation slide (A) to the left to release the insertion opening for the crank.
3. Insert crank and turn it by approx. 10 turns to the left (B) until the position indicators show that the "OFF" position of the earthing switch (D) and the circuit-breaker (E) has been reached completely (E). The circuit-breaker is first switched off automatically.
4. Remove crank.

Initial situation:
- Circuit-breaker OFF
- Spring mechanism of circuit-breaker charged
- Disconnector OFF
- Earthing switch OFF
- Interrogation slide blocked

Fig. 33 Switching the earthing switch ON manually

Fig. 34 Switching the earthing switch OFF manually
5.6 Standard switching operations

Notice:
Observe operating specifications (Chapter 5.6, page 35).

5.6.1 Switching outgoing feeder cable ON

Initial situation
- Circuit-breaker OFF
- Disconnector OFF
- Earthing switch OFF

Fig. 35 Switching outgoing feeder cable ON
1. Switch disconnector ON (A).
2. Switch circuit-breaker ON (B).

Fig. 36 Isolating outgoing feeder cable from power supply
1. Switch circuit-breaker OFF (B).
2. Switch disconnector OFF (A).

5.6.2 Earthing the outgoing feeder cable

Initial situation
- Circuit-breaker OFF
- Spring mechanism charged
- Disconnector OFF
- Earthing switch OFF

Fig. 37 Earthing the outgoing feeder cable
Switch earthing switch ON (A). The circuit-breaker (B) is switched ON automatically (see Chapter 5.5.2, page 38).

Fig. 38 De-earthing the outgoing feeder cable
Switch earthing switch OFF (A). The circuit-breaker (B) is switched OFF automatically (see Chapter 5.5.2, page 38).
5.6.3 Connecting busbar sections with bus section coupler

Initial situation
- Circuit-breaker OFF
- Both disconnectors OFF
- Both earthing switches OFF

Fig. 39 Connecting busbars
Fig. 40 Disconnecting busbars

1. Switch both disconnectors ON (A and B).
2. Switch circuit-breaker ON (C).
1. Switch circuit-breaker OFF (C).
2. Switch both disconnectors OFF (A and B).
5.7 Earthing the busbar

**Warning!**
Risk of short-circuit! The disconnectors on the appropriate busbar sections must be in position “OFF”!

**Notice:**
- Observe operating specifications (Chapter 5.3, page 35).
- Check busbar for isolation from power supply.

5.7.1 Earthing the busbar by means of a feeder via its circuit-breaker

The earthing device can be connected in the cable connection area either to inner cone-type test connectors or to outer cone-type cable connectors (earth adapter required). The earthing device and the earthing adapter are not included in the scope of supplies.

**Notice:**
Comply with the specifications of the manufacturer of the earthing device and - if applicable - the earthing adapter.

**Initial situation**
- Feeder is earthed -
  - Circuit-breaker ON
  - Disconnector OFF
  - Earthing switch ON

**Fig. 41 Earthing the busbar**

1. Mounting earthing adapter and earthing device to the outer cone-type connection system.
2. Switch earthing switch OFF (A).
3. Switch disconnector ON (B).
4. Switch circuit-breaker ON (C).

**Fig. 42 De-earthing**

1. Switch circuit-breaker OFF (A).
2. Switch disconnector OFF (B).
3. Switch earthing switch ON (C). The circuit-breaker is switched ON automatically again.
4. Remove earthing device from the outer cone-type connection system.
5. Close high-voltage terminal in a surge-proof fashion.
5.7.2 Earthing the right-hand busbar by means of the bus section coupler

![Diagram of right-hand busbar earthing](image1)

**Initial situation**
- Circuit-breaker OFF
- Both disconnectors OFF
- Both earthing switches OFF

1. Switch right-hand disconnector ON (A).
2. Switch left-hand earthing switch (B) ON. The circuit-breaker (C) is switched ON automatically (see Chapter 5.5.2, page 38).

![Diagram of de-earthing right-hand busbar](image2)

1. Switch left-hand earthing switch OFF (B). The circuit-breaker (C) is switched OFF automatically (see Chapter 5.5.2, page 38).
2. Switch right-hand disconnector OFF (A).

5.7.3 Earthing the left-hand busbar by means of the bus section coupler

![Diagram of left-hand busbar earthing](image3)

**Initial situation**
- Circuit-breaker OFF
- Both disconnectors OFF
- Both earthing switches OFF

1. Switch left-hand disconnector ON (A).
2. Switch right-hand earthing switch (B) ON. The circuit-breaker (C) is switched ON automatically (see Chapter 5.5.2, page 38).

![Diagram of de-earthing left-hand busbar](image4)

1. Switch right-hand earthing switch OFF (B). The circuit-breaker (C) is switched OFF automatically (see Chapter 5.5.2, page 38).
2. Switch left-hand disconnector OFF (A).
6.1 Voltage transformer

The system uses inductive voltage transformers.

- single-pole insulated and metallically shielded voltage transformers,
- fully shrouded and earthed,
- arranged outside of the gas compartment,
- connected to the high-voltage side via inner cone-type bushings,
- can be replaced without intervention in the gas compartment.

Voltage transformers on the cable connection are mounted completely, connected ready for operation and tested in the factory.

The voltage transformers feature a disconnecting device on the high-voltage side. Thus, high-voltage tests can be performed on the switchgear or on mounted high-voltage cables while the voltage transformers are earthed via a disconnecting device.

Voltage transformers on the busbar are mounted completely, connected ready for operation and tested in the factory.

The voltage transformers can optionally be equipped with a disconnecting device on the high-voltage side. Thus, high-voltage tests can be performed on the switchgear while the voltage transformers are earthed via a disconnecting device.
6.2 Removing cable compartment cover

Operation of the disconnecting device is directly arranged behind the cable compartment cover.

**Warning!**
After removal of covers, operator safety regarding internal faults may be reduced. Optimum operator safety is only ensured if the cable compartment is completely isolated from the power supply and earthed for assembly work.

An optional mechanical interlock prevents the cable compartment cover from being removed as long as the earthing switch is not switched ON.

<table>
<thead>
<tr>
<th>Interlocking matrix</th>
<th>Earthing switch</th>
<th>Cable compartment cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cable compartment cover</strong></td>
<td>attached</td>
<td>unlocked</td>
</tr>
<tr>
<td></td>
<td>removed</td>
<td>locked</td>
</tr>
<tr>
<td><strong>Earthing switch</strong></td>
<td>ON</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>–</td>
</tr>
</tbody>
</table>

Removing cable compartment cover

1. Isolate outgoing feeder cable from supply and earth it (Fig. 49, A), see also Chapter 5.6.2, Page 39.
2. Push interlocking slide of cable compartment cover (Fig. 49, B) upwards. At the same time, the cable compartment cover is unlocked and actuation of the earthing switch (A) interrupted mechanically and electrically.
3. Release two screws on the lower end of the cable compartment cover (C).
4. Lift cable compartment cover slightly and remove it (D). After having removed the cable compartment cover, the slide cannot be pushed down any longer. The earthing switch remains locked.
6 Disconnecting voltage transformers

Re-mounting cable compartment cover

1. Reinsert cable compartment cover and lower it.
2. Fasten cable compartment cover with two screws at the bottom.
3. Push interlocking slide down. The cable compartment cover is locked and the earthing switch re-enabled.

6.3 Actuating the disconnecting device

**Danger!**
Voltage transformers for the busbar may be operating while the cable compartment cover is removed.
Mounting work on the voltage transformer may only be performed in the scope of the applicable safety provisions if the voltage transformer is earthed.

**Warning!**
In case of faulty voltage transformers or faulty wiring, an internal arc may occur when the disconnecting device is operated while the system is live.
Disconnecting devices for voltage transformers may only be actuated in de-energized condition.
- Voltage transformer on cable connection: isolate outgoing feeder cable from power supply
- Voltage transformer on busbar: isolate busbar from power supply

Initial situation:

- Voltage transformer EARTHED

The slide mechanism of the disconnecting device can be locked by means of an U lock in ON or EARTHED position (Fig. 50, A). The U lock is not included in the scope of supplies provided by the factory.

Observe the position indications on the disconnecting devices.
6 Disconnecting voltage transformers

Switching the voltage transformer ON

1. Remove U lock (Fig. 50, A).
2. Remove locating pin (B). Push handle (C) forward quickly, until the position indicator has reached "ON" (D) and the locating pin is re-engaged. The disconnecting device moves onto the closing contact (voltage transformer switched ON).
3. Reposition the U lock.

Earthing the voltage transformer

1. Remove U lock (Fig. 51, A).
2. Remove locating pin (B). Pull handle (C) backwards quickly, until the position indicator has reached "earthed" (D) and the locating pin is re-engaged.
3. Reposition the U lock.
7 Servicing

7.1 Safety provisions

The work described in this manual may only be performed by specialist electricians with proven experience in conjunction with the GMA series and the applicable safety provisions.

Please read the whole manual carefully before working on the switchgear.

Before starting work on the switchgear, take the following into account:

- **Warning!**
  After removing covers from a switchgear unit, operator safety may be reduced regarding internal arcs unless the switchgear is isolated from the power supply. Optimum operator safety is only ensured if the switchgear is completely disconnected from the power supply and grounded during assembly.

- **Danger!**
  Risk of fatalities due to high voltage. Isolation from high voltage and earthing must always be ensured before performing assembly or maintenance work.

- **Danger!**
  Risk of fatalities due to supply voltage. Isolation from supply voltage must always be ensured before performing assembly or maintenance work.

- **Warning!**
  Risk of injury due to movable parts in mechanical drives. For maintenance work,
  - isolate the system from the supply voltage
  - release the circuit-breaker’s energy storing device by OFF-ON-OFF operation

- **Warning!**
  Risk of injury due to mechanically precharged drive components. The drive mechanisms must not be disassembled for maintenance work.

- **Warning!**
  Neither drill holes into nor open gas tanks. Risk of loss of insulation gas.
7.2 Servicing schedule

Insulation gas
GMA series panels have a hermetically sealed pressure system in accordance with IEC 62271-200. It does not require servicing over its entire service life (see also Chapter 3, as of page 21).

Tanks
The pressure tanks are made of stainless, non-magnetic steel.
- The tank must be kept free from any deposits of external metal.
- Any risk of pitting corrosion must be avoided.

Switching units
The components in the cladded high-voltage parts of the panel (vacuum circuit-breaker, disconnector and earthing switch) do not require any maintenance either.

Drive mechanisms / covers
Drive mechanisms and covers outside of the enclosure are corrosion-protected. Damage to the paint, scratches and deterioration must be repaired immediately to avoid corrosion.

Series GMA indoor switchgear units are designed for normal operating conditions according to IEC 62271-1.

Inspection
It is recommended to check the panels visually on a regular basis depending on the strain they are subject to during operation and in accordance with the national regulations.

Notice:
In case of frequent condensation or air pollution (dust, smoke or corrosive gases), the maintenance intervals must be reduced accordingly.

A visual inspection includes a complete check of the panels by certified staff for contamination, condensation and damage.

Maintenance
Should impurities or condensation be detected, the panels must be cleaned in an expert fashion. To this effect, only cleaning products approved by the manufacturer may be used (see Chapter 8.1, page 52).

Check the drives for sufficient lubrication. Subsequently, the functionality of the drives, interlocks and position indicators must be checked (see Chapter 5 as of page 26).

Repair
If damage is detected on the panels, it must be repaired or components be replaced immediately (see Chapter 7.3, page 49).

In case of ambiguities or irregularities, please contact the manufacturer’s Service Center immediately.

<table>
<thead>
<tr>
<th>Maintenance interval</th>
<th>Work to be carried out</th>
<th>Qualification / Work performed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>after 20 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ once the max. admissible number of breaking operations for the vacuum chambers has been reached (see Chapter 7.8, page 51) or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ after 2000 operating cycles of the disconnector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ 1000 operating cycles of the earthing switch</td>
<td>Revision of the panel / replacement of a panel</td>
<td>Manufacturer’s Service Center</td>
</tr>
<tr>
<td></td>
<td>Grease drives (see Chapter 7.7, page 50) and perform operating tests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check releases/blocking coils</td>
<td>Staff who have been certified for this work</td>
</tr>
</tbody>
</table>
7 Servicing

7.3 Replacement of components or panels

The drive mechanisms, current transformers and voltage transformers as well as the testing and monitoring systems can be replaced if necessary.

Also, entire panels can be replaced. To this effect, contact the manufacturer’s Service Center.

The following data on the nameplate are relevant for replacement of components or panels, or in case of any queries:
- Type designation
- Serial number
- Year of construction

7.4 Cleaning

When deposited dirt and humidity are detected, the panels must be cleaned in an expert fashion.

When cleaning, make sure that the lubrication in the drive mechanisms is not removed. If the drive mechanisms are no longer sufficiently lubricated, new lubrication must be applied.

| Slight contamination          | Clean using a dry, lint-free cloth. Depending on the degree of soiling, replace cloth as often as necessary. |
| Severe soiling                | Use cleaning agent, 1 litre can (see Chapter 8.1, page 52). The use of other cleaning agents is not admissible. |
|                              | - Wear protective gloves                                      |
|                              | - Use cleaning agent according to manufacturer’s instructions |
|                              | - Soak the cloth thoroughly and wipe the insulating components. Keep duration of exposure as short as possible. |
|                              | - Expose the cleaned surface to the air for at least two hours. |

7.5 Avoiding condensation

To ensure the specified insulating level, the panel – especially its insulating components – must not be exposed to condensation.

<table>
<thead>
<tr>
<th>Measures to take in case of condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- If there are signs of condensation: clean panels (see Chapter 7.4, page 49).</td>
</tr>
<tr>
<td>- Installation or inspection of panel heating. It must provide a sufficient heating performance to prevent condensation on the panels.</td>
</tr>
<tr>
<td>- Condensation can also be prevented by ensuring suitable ventilation and heating of the station or by using de-humidification devices.</td>
</tr>
</tbody>
</table>

7.6 Corrosion protection

Drive mechanisms and covers have a long-term protection against corrosion.

Any scratches and other damage must be repaired immediately to avoid corrosion. Contact the manufacturer’s Service Center.
7.7 Lubrication instructions

Maintenance work may only be performed by specialists who are familiar with the switching devices installed and the drive mechanisms they use.

Once the operating shutter has been removed, the drive is accessible from the switchgear front end (see assembly instructions). Remount operating shutter once maintenance is finished.

Points of lubrication

All joints and all surfaces in the circuit-breaker, disconnector and earthing switch drives which are sliding on each other must be lubricated.

The drive is completely lubricated at the factory with synthetic lubricant (KL).

Notice:

- The bearings and joints must not be washed out by the cleaning agent.
- The following elements must not be lubricated:
  - Motor
  - Auxiliary releases, push switches, blocking coils, auxiliary switches
  - Plastic bearing bushes and free wheeling
  - 3-position switch, drive: ratchet wheels and pawl tips
- Only approved lubricants may be used (see Chapter 8.1, page 52).

Lubrication procedure

- Synthetic lubricant (KL) for surfaces sliding on each other.
  Clean lubricating points, e. g. using a lint-free cotton cloth or a soft paintbrush and cleaning agent (use sparingly, just moisten points of lubrication). Apply a thin coat of lubricant (using e.g. a paintbrush).

- Liquid lubricant FL for bearings, joints and guide systems.
  Pour drops of liquid lubricant (oil can, drip feed lubricator) into the bearing gap. Liquid lubricant gets between the bearing surfaces due to the capillary effect. In case of inaccessible lubrication points, use an extension tube or spray.
7.8 Maximum admissible number of breaking operations of the vacuum chambers

The diagram (Fig. 53) defines exclusively the maximum admissible breaking numbers of the circuit-breaker depending on the rated normal current \( I_r \) and of the short-circuit breaking current \( I_{sc} \). It indicates when the vacuum interrupter chambers need to be replaced.

The diagram shows examples of values for the rated normal current \( I_r \) and the short-circuit breaking current \( I_{sc} \).

The data for the rated normal current \( I_r \) and the short-circuit breaking current \( I_{sc} \) are indicated on the nameplate (Fig. 52, item 1).

---

**Fig. 52**
Data for rated normal current \( I_r \) and short-circuit breaking current \( I_{sc} \) on the nameplate

**Fig. 53**
Admissible numbers of breaking operations for the vacuum chamber with values (example)
- \( I_r = \) rated normal current = 1.6 kA
- \( I_{sc} = \) short-circuit breaking current = 31.5 kA
8.1 Auxiliary products

Only the following auxiliary products may be used, which can be purchased from the manufacturer. The use of other auxiliary products is not admissible.

**Warning!**
Risk of injury if the auxiliary products are handled improperly. Comply with the safety data sheets of the auxiliary products.

<table>
<thead>
<tr>
<th>Auxiliary products</th>
<th>Ref. no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning agent, 1-l can</td>
<td>S 008152</td>
</tr>
<tr>
<td>Synthetic lubricant (KL) 0.5 kg can</td>
<td>ST 312-111-835</td>
</tr>
<tr>
<td>Liquid lubricant FL 0.5-l can</td>
<td>S 008 153</td>
</tr>
</tbody>
</table>
| Touch-up pen, 50ml (specify colour shade):  
  – Covers RAL 9003 (white)  
  – Operating shutter RAL 7016 (anthracite grey)  
  – Special paint | S 009 562 |

8.2 Accessories

Ref. no. AGS  007165-01

The mobile accessory board can be suspended centrally on a wall of the switchgear building via two securing bolts, and can be removed if required.

A handle ensures safe transport.

A mobile accessory board can accommodate the following elements:

- crank of 3-position switch
- emergency crank, energy-storing device of the circuit-breaker
- double-bit key
- kit of pluggable voltage indicators (3 ea.)
- switchgear documentation (DIN A4)

![Mobile accessory board, suspended in the handle profile of the cable compartment cover](image-url)
These accessories are supplied together with the panel. The panel may only be operated by means of these accessories.

Double-bit key for locking and unlocking of the low-voltage cabinet door
Ref. no. AGS 434101-01

Crank for disconnector and earthing switch drive with torque limitation
Ref. no. AGS 000440-01

Spring charging crank for circuit-breaker spring operating mechanism
Ref. no. AGS 617831-01

Optionally available for the Integrated Voltage Detecting System IVIS

Phase comparator DEHNcap / PC-LRM
Ref. no. AGS C26320-01
As our products are subject to continuous development, we reserve the right to make changes regarding the standards, illustrations and technical data described in this Technical Manual. For any requests, please contact the address given below.

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