Type GM-SG 5 kV and 15 kV metal-clad switchgear selection and application guide

E50001-F710-A122-X-4A00

Answers for energy.
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>2 - 7</td>
</tr>
<tr>
<td>Construction</td>
<td>8 - 14</td>
</tr>
<tr>
<td>Accessories</td>
<td>15 - 16</td>
</tr>
<tr>
<td>Protective relays</td>
<td>17</td>
</tr>
<tr>
<td>Vacuum circuit breakers</td>
<td>18 - 24</td>
</tr>
<tr>
<td>Ratings</td>
<td>25 - 31</td>
</tr>
<tr>
<td>Dimensions</td>
<td>32 - 35</td>
</tr>
<tr>
<td>Side views</td>
<td>36 - 37</td>
</tr>
</tbody>
</table>
Overview

Siemens GM-SG 5 kV, 7.2 kV and 15 kV metal-clad power switchgear assemblies with horizontal drawout type GMSG vacuum circuit breakers take advantage of the latest developments in vacuum interrupter technology. Up to two circuit breakers can be stacked in a single vertical section, allowing significant space savings.

The equipment meets or exceeds the latest standards of ANSI, IEEE and NEMA.

GM-SG switchgear is designed for use in industrial plants, commercial buildings, electric utility systems, cogeneration installations and other electrical systems. It is commonly used for protection and switching of transformers, motors, generators, capacitors, buses, distribution feeder lines and, in general, for protection of any medium-voltage power circuit.

Siemens’ experience gained in over 80 years of supplying metal-clad switchgear in the U.S. has been captured in the GM-SG design. The objective has been to incorporate features designed to provide safety, while simplifying operation, maintenance and minimizing installation cost.

The switchgear structure and the drawout vacuum circuit breaker are an integrated design, with dielectric, thermal and interruption integrity built directly into the basic design, not as an afterthought.

**Siemens 3AH3 operating mechanism**

The GMSG circuit breaker uses the proven Siemens 3AH3 stored-energy operating mechanism. This operator is an evolution of the 3A family of operators first introduced in 1976. Over 60,000 3AH3 operating mechanisms have been produced since 1998.
Overview

Figure 2: GM-SG switchgear 1200 A or 2000 A circuit breaker section
Overview

Faster interruption
Standard interrupting time is five-cycles with an option available for three-cycle interrupting time.

Siemens vacuum interrupters
The vacuum interrupters used in the GMSG circuit breaker are manufactured by Siemens and have been proven in thousands of installations since 1976. The chrome-copper contacts used in these interrupters are designed to assure low chopping levels and eliminate the need for surge protection on most circuits.

Front-mounted operating mechanism
The simple GMSG operating mechanism makes maintenance and inspection easy. The mechanism is located on the front of the circuit breaker, rather than underneath.

Maintenance intervals
If applied under ANSI “usual service” conditions, maintenance of the circuit breaker mechanism is designed to be needed at 10-year intervals.

Maintenance of the switchgear cubicle is recommended at five-year intervals and primarily consists of cleaning insulation.

Floor rollout
No lift truck or dolly is needed to insert or remove circuit breakers in the lower cell of switchgear located at floor level. For indoor switchgear located on a raised “housekeeping” pad or for outdoor non-walk-in switchgear, a lift truck is required to handle circuit breakers.

“Universal” spare circuit breaker (up to 50 kA)
The physical configuration and interlock logic allow the use of a single circuit breaker to serve as a “universal” spare breaker at an installation site for up to 50 kA. The interlock logic checks the principal rating characteristics (continuous current, maximum voltage and interrupting current) and allows a circuit breaker to be inserted in any circuit breaker cell provided that the circuit breaker equals or exceeds the ratings required by the cell.

“Universal” spare circuit breaker (63 kA)
The concept described above (for up to 50 kA) also applies for equipment rated 63 kA, within the 63 kA rating. Circuit breakers rated 63 kA cannot be used in equipment rated 50 kA or lower.

Single source responsibility
Single source responsibility is assured since the complete equipment is designed by Siemens and is manufactured and tested in a single facility. The vacuum circuit breakers are checked in the switchgear cells as part of production testing. The vacuum circuit breakers are shipped in the switchgear to assure interchangeability and to reduce the possibility of damage to the circuit breakers during shipment.

Full ANSI design background
Full design integrity is managed and controlled by Siemens. ANSI/IEEE C37.09 and C37.20.2 require design tests on circuit breakers and structures together. The 3AH3 operator design originates in Siemens’ global center of competence for circuit breakers in Berlin and final assembly of both the drawout GMSG circuit breaker and the switchgear structures occurs in a single facility. Siemens controls the entire process from design concept to production. Records are maintained to document compliance with ANSI/IEEE standards.
Overview

UL or C-UL Listing available
Where the arrangement of components allows, UL or C-UL Listing is available.

Quality systems
Facilities involved with application, engineering, design and production are certified to ISO 9001 requirements.

Structural flexibility
Siemens GM-SG metal-clad switchgear provides enhanced flexibility in locating circuit breaker, auxiliary and metering cells within the structure layout. Circuit breakers rated 1200 A, 2000 A and 3000 A may be located in upper or lower cell positions.

Bus sectionalizing (tie) circuit breaker cells may be located on the upper or lower levels and are ordinarily located next to an auxiliary cell on the same level to accommodate transition bus work.

The 3000 A circuit breakers can be located either in the bottom cell or the top cell of a vertical section. If the 3000 A circuit breaker is located in the lower cell, the upper cell may be used for metering devices only.

If the 3000 A circuit breaker is in the upper cell, the lower cell may be used to house a set of drawout voltage transformers, a drawout control power transformer or rollout fuses for a remote control power transformer.

The 3000 A circuit breaker may be used for 4000 A continuous current applications, with the addition of fan cooling equipment in the auxiliary cell above or below the circuit breaker. This application of fan cooling is appropriate if loads above 3000 A are infrequent as, for example, in the case of a fan-cooled rating on a power transformer.

Each vertical section contains the main bus bar compartment plus a rear compartment for incoming and outgoing connections. The front portion of the vertical section contains a central secondary device compartment, located between two cells for auxiliary devices and/or circuit breakers, including primary and secondary disconnects, instrument transformers, instruments and relays, secondary wiring and other components as necessary. The switchgear is normally designed so that additional vertical sections may be added in the future.

Enclosure design
The GM-SG design includes full ANSI/IEEE C37.20.2 metal-clad construction. This means complete enclosure of all live parts and separation of major portions of the circuit to retard the spread of faults to other compartments.

Removable plates permit access to all compartments. The rear panels are individually removable to allow separate access either to downfeed or upfeed cable connections.

The structure is constructed of bolted steel for better dimensional control than with welded designs. Sheet steel inter-unit barriers extend the full height and depth of each vertical section for isolating adjacent sections. The ground bus extends the entire length of the complete switchgear lineup and to all circuit breaker cells.
Circuit breaker interchangeability

The GM-SG switchgear cubicle and the removable GMSG circuit breaker element are both built to master fixtures so circuit breakers of the same ratings are interchangeable with each other even if the circuit breaker is required for use with a cell with "provisions only" supplied years earlier. The GMSG circuit breaker is not interchangeable with the older designs.

A circuit breaker of higher rating (up to 50 kA) can be used in a cell of equal or lower rating. For example, a 3000 A 50 kA 15 kV circuit breaker can be used in a 1200 A 25 kA 15 kV circuit breaker cell.

The same is true for 63 kA rated circuit breakers. The 63 kA rated circuit breakers, however, can only be used in 63 kA rated cells, and lower rated circuit breakers cannot be used in 63 kA rated cells.

Tested to ANSI/IEEE standards

Siemens GM-SG switchgear is tested to meet the requirements of ANSI/IEEE standards. A complete design test program, including short circuit interruption, load current switching, continuous current, mechanical endurance, close and latch current, short time and momentary withstand, impulse withstand and the other tests required by the standards, has been successfully completed. These tests encompass the complete equipment design, including both the switchgear structure and the circuit breaker removable element.

Production tests in accordance with ANSI/IEEE standards are performed on every group of switchgear and on each circuit breaker. Certified copies of all test data can be furnished to customers upon request.

The switchgear is not classified as arc-resistant switchgear and has not been tested for resistance to internal arcing per IEEE C37.20.7.

Qualification to seismic requirements of various codes (for example, IBC-2006, UBC and IEEE 693) is available. Consult Siemens with detailed requirements.

UL or C-UL Listing available

When specified, if the component configuration allows, the switchgear can be provided with the UL or C-UL (for use in Canada) Listed label, indicating conformance to the requirements of ANSI C37.54 and ANSI C37.55.
Construction

Switchgear compartments

Vacuum circuit breaker cell
The circuit breaker cell is a bolted, reinforced, sheet steel enclosure with provisions for a type GMSG vacuum circuit breaker. It includes a hinged front door, inter-compartment and inter-unit barriers, primary and secondary disconnects, racking mechanism, interlocks, instruments and relays, control wiring and devices and current transformers, as required by the application.

Vacuum circuit breaker element
The GMSG vacuum circuit breaker includes a stored energy operating mechanism, primary and secondary disconnects, auxiliary switch, ground contact, control wiring and interlocks.

Auxiliary cell
An auxiliary cell is similar to a circuit breaker cell, except without provisions for a circuit breaker. Space may be used for voltage transformers (VTs), control power transformers (CPTs) and fuses, or other auxiliary devices. Opening of the front door does not automatically disconnect VT, CPT or rollout fuse trays located inside the cell.

Bus compartment
The bus compartment is a separately enclosed space for three-phase insulated main power bus bars, supports and connections to circuit breaker cells.

Primary termination compartment
The rear area of the unit includes space for connecting incoming or outgoing power cables, bus duct connections, transformer connections or surge protection devices. In stacked configurations, outgoing power connections for the upper cell are isolated from those for the lower cell.

Figure 6: Central compartment for panel devices

Circuit breaker cell features

Relay and instrument space
The circuit breaker cell front door is suitable for mounting the most common relays, meters, test switches, control switches and similar devices typically used on metal-clad switchgear.

Floor rollout
Circuit breakers in the lower cell can be rolled out directly on the floor in front of the unit without a handling device, lift truck, or hoist for indoor (if not on raised “housekeeping” pad) and Shelter-Clad installations. A lift truck accessory is optionally available for handling circuit breakers in upper cells or in non-walk-in outdoor enclosures.

Closed door racking
The circuit breaker can be racked in or out with the cell door open or closed. The mechanism includes an indicator to show the racking mechanism position with the door closed. For racking, a manual drive crank or an optional electric motor drive may be used.

Electrical racking accessory (optional)
An electrical racking motor accessory is available. This consists of a motor drive assembly, which installs (without tools) on mounting brackets on the switchgear front panel of a circuit breaker compartment. The unit includes a power cord, which can be plugged into a duplex receptacle in the vicinity of the switchgear, plus a control cable, which allows the operator to control the racking operation from a distance. An alternative arrangement is available, which includes a control box that can be mounted at a distance from the switchgear and permanently connected to control power. In turn, the racking motor can be connected to the control box with a long cord.
Interlocks prevent moving a closed circuit breaker in the cell by preventing engagement of the racking crank (or electric racking accessory) if the circuit breaker is closed.

A second interlock lever holds the circuit breaker mechanically and electrically trip free between positions. The racking mechanism can be padlocked to restrict unauthorized racking of the circuit breaker.

Separate padlock provisions may be used to hold the circuit breaker in the trip-free condition.

Automatic shutters

Automatically operated grounded steel shutters allow or block access to the stationary primary disconnects. The shutters are opened by the circuit breaker as it moves toward the connected position. The shutters close as the circuit breaker is racked away from the connected position to the test position. The shutters remain closed until they are forced open by insertion of the circuit breaker. This design enhances protection for personnel compared to shutters that are linked to the racking mechanism.

Current transformers

Front-access current transformers may be mounted around both the upper and lower stationary primary disconnect bushings. Up to four standard accuracy current transformers per phase may be located in each circuit breaker cell.

Wiring

Secondary wiring is neatly bundled and secured on the sides of the cell. Wiring is not routed on the floor of the switchgear as in some other manufacturers’ designs.

Primary disconnects

The cubicle stationary primary disconnect contacts are recessed inside the insulator assemblies and are located behind grounded steel shutters to prevent accidental contact when the circuit breaker is withdrawn. The primary disconnect finger clusters are mounted on the circuit breaker.

Secondary disconnects

The cubicle-mounted stationary disconnect contacts mate with spring-loaded secondary contacts on the side of the circuit breaker. The secondary disconnects automatically engage in both the test and connected positions and they remain engaged between these positions.

Mechanism-operated cell (MOC) switch

When required, up to 24 stages of the MOC auxiliary switch can be mounted in the circuit breaker cell. All spare MOC contacts are wired to accessible terminal blocks for user connections. These MOC switches are operated only when the circuit breaker is in the connected position. Optionally, they may be arranged to operate in both the connected and test positions.

Truck-operated cell (TOC) switch

When required, up to 12 stages of TOC switch can be mounted in the circuit breaker cell. All spare TOC contacts are wired to accessible terminal blocks for user connections.

Unobstructed terminal block space

Terminal block areas are located on each side of circuit breaker or auxiliary cells. Since racking system components are not mounted on the cubicle sides, the side-mounted terminal blocks are not obstructed as in other designs. Installation of field wiring is simplified, as wiring can be easily laid directly against the side sheets. It is not necessary to “fish” the wiring under, around and through obstructions.
Construction

Figure 7: Circuit breaker cell interior

- Secondary disconnect
- Current transformer barrier
- Shutters, primary disconnects (behind shutters) and current transformers (behind barrier)
- Ground bar
- Racking mechanism
- Racking mechanism padlock provisions
- Truck-operated cell switch (TOC) (optional)
- White interior device panels
- Mechanism-operated cell switch (MOC) (optional)
- Shutter operating linkage
- Ratings interlocks
- Trip-free padlock provisions
Secondary control devices
The secondary control devices for the upper and lower circuit breaker cells are located in the central secondary device cell. The cell can accommodate pullout fuse holders or molded case breakers to suit the protective practices of the purchaser and can also accommodate auxiliary relays, transducers or similar devices.

Auxiliary cells
Auxiliary cells are constructed in a similar manner as the circuit breaker cells, except without provisions for a circuit breaker element. Auxiliary cells may be located in the top or bottom of a vertical section. The front door panels may be used to mount meters, relays or other instrumentation.

The cubicle portion of the cell may be used for mounting devices such as voltage transformers, control power transformers, automatic transfer switches or other auxiliary devices. Rollout trays may be included for mounting VTs, CPTs or fuses for fixed-mounted CPTs. If a rollout auxiliary tray is provided, the cell door is the height of the rollout cell. Opening of the front door does not automatically disconnect VT, CPT or rollout fuse trays located inside the cell.

Auxiliary cell relay and instrument space
The front panel of auxiliary cells is suitable for mounting of devices. If the auxiliary cell contains rollout tray devices (VTs, CPT or rollout fuses), the space available allows for mounting of devices with limited depth, for example, test switches, instruments, transfer switches, etc. and can accommodate many relay types with the use of a projection frame. If the auxiliary cell does not contain a rollout tray, the panel is suitable for mounting any of the devices commonly specified for use on metal-clad switchgear.

Voltage transformers (VTs)
Up to three VTs (single-fused) with their integrally mounted current limiting fuses may be mounted on each rollout tray. The upper and lower cells can each accommodate up to two rollout trays. When moving to the disconnect position, the primary fuses are automatically disconnected and grounded to remove any static charge from the windings. The secondary connections are also disconnected when the rollout tray is moved to the disconnect position. When the rollout tray is withdrawn, insulated shutters cover the cubicle primary disconnects helping to protect personnel from exposure to energized components.

Control power transformers (CPTs)
One single-phase CPT of up to 15 kVA capacity, with its primary current limiting fuses and secondary breaker, may be mounted on the rollout tray of an auxiliary cell. The secondary molded case breaker is interlocked with the rollout tray such that the secondary breaker must be open before the CPT primary can be disconnected or connected. This prevents load current interruption on the main primary contacts. With the secondary breaker open and the latch released, the tray can be rolled easily to the disconnect position. As the tray rolls out, the primary fuses are automatically grounded to remove any static charge and insulated shutters close to shield energized conductors.

Large single-phase and all three-phase CPTs are stationary-mounted on the floor in the rear of the vertical section. The primary fuses for these large transformers are mounted on the rollout tray in the lower portion of the bottom auxiliary cell and key interconnected with the secondary breaker. Withdrawing the rollout tray closes the insulated shutters.
Construction

Figure 10: Auxiliary cells

VTs, CPT or rollout fuses for stationary CPT located in the bottom two cells.

VTs, CPT or rollout fuses for stationary CPT located in rear or remote.

Rollout VT

Rollout CPT

Rollout fuses

Stationary mounted CPT (over 15 kVA single-phase; all three-phase CPTs)
An alternative arrangement is available in which the rollout fuse tray is mounted in the lower position of the upper auxiliary cell and the control power transformer is installed in the lower auxiliary cell. This option is available only if the CPT size is compatible with the dimensions of the lower auxiliary cell.

**Current transformers (CTs)**

Siemens toroidal CTs comply with ANSI/IEEE standards and are mounted at the rear of the circuit breaker cell. Up to four standard accuracy type MD CTs may be mounted on each phase: two on the bus side and two on the load side, around the primary disconnect bushings. CTs may be added or changed with the cell de-energized without removing bus bar or cable connections. Multi-ratio CTs are available.

For higher accuracy, type MDD CTs are available. Due to their larger physical size, only one MDD CT can be installed on each side of the circuit breaker.

**Primary termination compartment**

The primary termination compartment is located at the rear of the switchgear and is separated from all other compartments by metal barriers. When two circuit breakers are located in the same vertical section, their primary cables are separated by steel horizontal barriers and by an enclosed vertical cable duct when both sets of cables exit in the same direction.

Upper and lower bolted rear plates are standard and provide separate access to the cable area for each circuit breaker. Infrared (IR) viewing windows are optionally available for use in checking temperature of conductors in the primary termination compartment.

**Bus bar system**

The main bus bar system is enclosed by grounded metal barriers and feeds both the upper and lower cells in a vertical section. Full-round-edge copper bus bar with silver-plated joints is standard. Tin-plated copper bus is available as an option. High strength Grade 5 steel hardware with split lock washers helps maintain constant pressure, low resistance connections. A copper ground bus bar is standard in all vertical sections.

**Bus bar insulation**

Bus bars have fluidized bed, flame-retardant, track-resistant, epoxy insulation. The epoxy is bonded to the bus bars, to reduce the possibility of corrosion due to intrusion of gas or moisture between insulation and bus bar.

**Bus joint insulation**

For normal joint configurations, bolted bus joints are insulated by pre-formed molded polyvinyl boots that are held in place by nylon hardware. Preformed insulating materials eliminate the need for molding and taping joints when connecting shipping groups in the field, reducing installation time and costs. The same preformed, high dielectric strength joint boots used in factory assembly are also used in field assembly of shipping-split bus connections. For uncommon joint configurations, taped joint insulation is used. Boots for insulating user’s power connections are available as an option.

**Bus support insulation**

Track-resistant, flame-retardant glass polyester insulation components are used to produce a uniform and high quality insulation system. Bus bar supports and primary disconnect bushings are molded from high-impact strength insulation with high dielectric strength and low moisture absorption (non-hygroscopic) characteristics.

As an option, a high track-resistance material, similar to glass polyester, is also available for certain bus support insulators.
Construction

Wiring
The secondary and control wiring is connected to terminal blocks, which have numbered points for identification. One side of the terminal blocks for all connections leaving the switchgear is reserved for external connections. Secondary and control wire is minimum No. 14 AWG, extra flexible, stranded type SIS wire, insulated for 600 volts, except when devices (for example, transducers, communicating devices, etc.) require different wire. Insulated barrel, crimp-type locking fork terminals are used for most applications except where the devices require a different type of terminal. Where they pass through primary compartments, secondary control wires are armored or enclosed in grounded metal wire covers or sheaths.

Instrumentation and relays
Instruments, meters and relays can be traditional switchboard type or modern electronic type, depending on the requirements of the specification. If traditional electromechanical devices are used, they have semi-flush cases with dull black covers. Indicating and recording instruments, meters and relays are of the rectangular type, semi-flush mounted. All scales have a suitable range and are designed with black letters on a white background.

Control and instrument switches
Switches furnished are rotary, switchboard type and have black handles. Circuit breaker control switches have pistol-grip handles, while instrument transfer switches have round notched handles and auxiliary or transfer switches have oval handles.

Circuit breaker control switches have a mechanical flag indicator showing a red or green marker to indicate the last manual operation of the switch.

Outdoor housings
Two types of outdoor housing, non-walk-in and Shelter-Clad, are available to meet almost any application. For both types, the underside of the base is coated with a coal tar emulsion. The switchgear is shipped in convenient groups for erection in the field.

Non-walk-in design
The non-walk-in switchgear consists of indoor type circuit breaker and auxiliary cubicles located in a steel housing of weatherproof construction. Each vertical section has a full height exterior front door with provision for padlocking. Each cell is also equipped with an inner-hinged front door for mounting relays, instrumentation and control switches. Two removable rear panels are included for cable access to the primary termination area. Each cubicle includes necessary space heaters, a switched lamp receptacle for proper illumination of the cubicle during maintenance and inspection and a duplex receptacle for use with electric tools. A molded-case circuit breaker for space heaters is located in one cubicle.

Shelter-Clad single-aisle design
The Shelter-Clad switchgear consists of indoor type circuit breaker and auxiliary cubicles located in a weatherproof steel housing having an operating aisle space of sufficient size to permit withdrawal of the circuit breakers for inspection, test or maintenance. An access door is located at each end of the aisle arranged so that the door can be opened from the inside regardless of whether or not it has been padlocked on the outside. The aisle space is provided with incandescent lighting, which is controlled by means of a three-way switch at each access door. Each cubicle includes necessary space heaters. Each lineup includes two utility duplex receptacles, one at each aisle access door, for use with electric tools, extension cords, etc. The weatherproof enclosure for the aisle-way is shipped disassembled for erection in the field. Optionally, for single-aisle configurations, the aisle portion of the enclosure can be shipped assembled.
Accessories

Standard accessories include:

- Manual racking crank
- Spring charging crank
- Drawout extension rails (facilitate handling of circuit breakers in upper cell)
- Lifting sling (for circuit breakers above floor level)
- Split plug jumper (standard unless test cabinet is furnished)
- Contact lubricant
- Touch-up paint.

Optional accessories include:

- Circuit breaker lift device
- Test cabinet (in place of split plug jumper)
- Test plugs (if required by devices)
- Electric racking motor assembly (to enable racking while operator is at a distance from the switchgear)
- Manual or electrical ground and test device.

Test provisions, either a split plug jumper or a test cabinet, are available for testing the circuit breaker outside its cubicle.

The split plug jumper is used to bridge the secondary disconnects with a flexible cable, so the circuit breaker may be electrically closed and tripped with the control switch on the instrument panel while the circuit breaker is outside of its compartment. The test cabinet, including a control switch, is used for closing and tripping the circuit breaker at a location remote from the switchgear.
Manual ground and test device (up to 50 kA)

This is a drawout element that can be inserted into a circuit breaker cell rated for a short-circuit current of 50 kA or lower. It opens the shutters, connects to the cell primary disconnecting contacts and so provides a means to make the primary disconnect stabs available for testing. It is suitable for high potential testing of outgoing circuits of the switchgear main bus or for phase sequence checking. It also provides a means to connect temporary grounds to de-energized circuits for maintenance purposes.

The manual ground and test incorporates three-position single-pole switches (upper stabs to ground, neutral and lower stabs to ground), eliminating the need for user-furnished ground cables. The switches are hookstick operable and are rated for the full momentary and short-time ratings of the associated switchgear. User-furnished grounding cables and commercially available ground clamps seldom have ratings equal to those of the switchgear.

Separate insulated hinged panels cover the upper and lower stabs and include padlock provisions. The device also includes individual hookstick-removable barriers between each single-pole switch and the upper stabs and lower stabs.

Electrical ground and test device (for up to 50 kA and for 63 kA)

An electrical ground and test device includes a power-operated switch (derived from a GMSG circuit breaker) arranged to allow grounding one set of disconnect stabs.

The electrically-operated ground and test device rated for a short-circuit current of 50 kA can be used in any GMSG circuit breaker compartment rated up to 50 kA.

The electrically-operated ground and test device rated for a short-circuit current of 63 kA can be used only in GMSG circuit breaker compartments rated 63 kA.

Neither the 50 kA device nor the 63 kA device require any adapters for use in 1200 A, 2000 A or 3000 A cells.

Two devices, one each for the upper and lower stabs, are required if grounding is desired to either side of the unit. The device also provides a means of access to the primary circuits for high potential tests or for phase sequence checking. These devices are able to close and latch against short-circuit currents corresponding to the ratings of the equipment. Due to the unique requirements frequently involved in such devices, all applications of electrically-operated ground and test devices should be referred to Siemens for review.

Note: Due to the special nature of ground and test devices, each user must develop definitive operating procedures for incorporating safe operating practices. Only qualified personnel should be allowed to use ground and test devices.
SIPROTEC

SIPROTEC has established itself across the market as the standard for numerical protective relaying. Besides the common system platform and the unique DIGSI 4 service interface that may be used for all protective devices, it also supports the new IEC 61850 communication standard.

What is IEC 61850 and what can it achieve?

Users and manufacturers jointly developed the new international standard IEC 61850, which was approved in 2004. The agreed aim of this standard is to arrive at a complete communication solution for substations, thus providing users with interoperability among different makes on the basis of Ethernet technology. This opens up a whole new dimension in efficient substation management. Not only short-term savings in operation and maintenance but also simplified engineering, less complexity, and long-term expandability can make you one of the winners in tomorrow's power market.

With SIPROTEC relays and bay control units from Siemens, we offer all the advantages of an expert and innovative partner in the field of protective relaying and substation automation. We bring you attractively priced intelligent solutions by paying particular attention to lowering your life cycle and system management costs. These solutions are the first ones available on the market complying with the international IEC 61850 standard.

To enable you to profit from these advantages as quickly as possible, Siemens collaborated in the preparation of this international standard and made every effort to ensure no time was lost in bringing it out. The result is certainly worth a look, because SIPROTEC and other Siemens power automation products and systems are available on the basis of the IEC 61850 standard and can even be retrofitted in systems supplied since 1998.

System advantages: one bay, one unit

The SIPROTEC 4 relay family offers fully integrated protection, control, monitoring and automation functions incorporated in a single device. For many applications, this product contains all the functions you need to meet all your protection and control requirements with just one unit per bay, saving on investment and installation costs and enhancing availability.

DIGSI 4

DIGSI 4 provides one tool for all tasks and products. DIGSI 4 is a computer program designed for all SIPROTEC relays. DIGSI 4 offers users a universal tool for all support tasks from setting and commissioning of devices to documentation and analysis of system faults. Our powerful analysis tool speeds up trouble-shooting and supplies important service information.
Vacuum circuit breakers

Maintenance features

The GMSG circuit breakers incorporate many features designed to reduce and simplify maintenance, including:

- Low maintenance vacuum interrupter
- Ten-year maintenance interval (assuming ANSI "usual service" conditions)
- Floor rollout
- Front-mounted operator
- Common operator family
- Simple outer-phase barriers
- "Universal" spare circuit breaker concept
- Non-sliding current transfer
- Rugged secondary disconnects.

Ten-year maintenance interval on GMSG circuit breaker

When applied under mild conditions (ANSI "usual service" conditions), maintenance is typically needed at ten-year intervals on the circuit breaker. The maintenance interval for the switchgear cubicles is five years.

Low maintenance requirements

The interrupter is a sealed unit so the only maintenance typically necessary is to clean off any contaminants and to check the vacuum integrity. The vacuum interrupters can be disconnected from the stored energy mechanism quickly, without tools and vacuum integrity inspected by hand; alternatively, a simple hi-pot test can be used.

Floor rollout

When located in the lower cell, the circuit breakers are arranged to rollout directly on the floor in front of the switchgear if the switchgear is not located on a "housekeeping" pad. No adapter, hoist or lift truck is necessary.

Siemens Type GMSG circuit breakers are available in 25 kA through 63 kA "constant kA" interrupting classes or 250 MVA through 1000 MVA on the older "constant MVA" rating basis. Continuous current ratings include 1200 A, 2000 A and 3000 A self-cooled. 4000 A is available using a 3000 A circuit breaker together with forced-air (fan) cooling in the switchgear cubicle.
Vacuum circuit breakers

Mechanism operation

The mechanism is arranged to pre-store closing energy in the closing springs. The closing springs are selected so that they provide sufficient energy not only to close the circuit breaker safely into maximum "close and latch" currents but also to pre-store the tripping energy necessary to open the circuit breaker. The closing springs can be manually charged during maintenance or in emergency conditions, but are normally charged electrically automatically after each closing operation.

Interlocks

The racking system prevents racking of a closed circuit breaker and keeps the circuit breaker trip free during racking. The racking mechanism can be padlocked to prevent unauthorized operation. Padlocks can also be applied to the racking mechanism to maintain the circuit breaker in the trip-free condition.

Stored energy operator

The GMSG circuit breaker utilizes the Siemens 3AH3 stored energy operator for long life, high reliability and ease of maintenance. Parts used in the manufacture of the circuit breaker are precision tooled or produced on numerically controlled equipment. The circuit breaker design includes frequent use of inherent alignment techniques.

Manual controls and indicators

All circuit breaker manual controls and indicators are conveniently located on the front of the circuit breaker. Standard features include manual close button, manual trip button, open-close indicator, stored energy closing spring charge / discharge indicator, manual spring charging access port and close operation counter.

Common operator family

Since the entire GMSG range of ratings uses a common stored energy operating mechanism design, less training of maintenance personnel is required and stocking of spare parts is reduced.

Front accessible operating mechanism

The GMSG stored energy operator is located at the front of the circuit breaker. The front cover can be easily removed to expose the operator for inspection and maintenance. This feature eliminates the need to tilt or turn over the circuit breaker for normal service.

Trip-free design

The operating mechanism conforms to the trip-free requirements of ANSI/IEEE standards. The mechanism design assures that the tripping function prevails over the closing operation.

Simple barriers

Outerphase barriers are of very simple design and located on the circuit breaker, allowing the cell to be free of barriers, except the current transformer barrier located in front of the shutters. The barriers on the circuit breaker remove quickly and easily for maintenance. Most maintenance can be performed with the barriers in place.

Vacuum interrupters

The GMSG circuit breakers use the Siemens family of vacuum interrupters, proven in over 600,000 circuit breakers produced since 1976. The cup-shaped contacts (used for lower interrupting ratings) have chrome-copper arcing rings with a unique radial magnetic field geometry to provide fast interruption with minimal contact erosion. For higher interrupting ratings, axial magnetic field contacts are used to maintain the arc in diffuse mode and minimize contact erosion. The chrome-copper contact material assures lower chopping currents than with designs employing copper-bismuth contacts.
Vacuum circuit breakers

Non-sliding current transfer

The vacuum interrupter movable stem is connected to the lower disconnect stab of the circuit breaker by a reliable flexible connector, a method pioneered by Siemens in the 1970s. This provides a low-resistance current transfer path, not subject to the wear and contamination problems associated with sliding or rolling joints used in some designs.

Primary disconnects

The primary connection between the circuit breaker and the cubicle is made of multiple sets of silver-plated copper finger contacts that engage with silver-plated copper stationary contacts. The cubicle primary disconnect studs have a tapered leading edge, which contributes to smooth racking of the circuit breaker.

The contacts, mounted on the ends of the circuit breaker disconnect stabs, have multiple fingers and are compression spring loaded (one spring per double pair of fingers). This arrangement offers a large number of contact points to ensure proper alignment. The circuit breaker finger assemblies are withdrawn with the circuit breaker and are available for inspection without de-energizing the switchgear main bus.

"Universal" spare circuit breaker (up to 50 kA)

The physical configuration and interlock logic allow the use of a single circuit breaker to serve as a "universal" spare circuit breaker at an installation site for up to 50 kA. The rating interlock (see Figure 7) logic checks the principal rating characteristics (continuous current, maximum voltage and interrupting current) and allows a circuit breaker to be inserted in a breaker cell provided that the circuit breaker equals or exceeds the ratings required by the cell.

"Universal" spare circuit breaker (63 kA)

The concept described above (for up to 50 kA) also applies for equipment rated 63 kA within the 63 kA rating. Circuit breakers rated 63 kA cannot be used in equipment rated 50 kA or lower.
Secondary disconnects
Circuit breaker-to-cubicle secondary disconnects are of the silver-plated sliding finger design. The secondary disconnects are automatically engaged as the circuit breaker is racked into the test position. They remain engaged as the circuit breaker is racked to the connected position. Since the secondary disconnects automatically engage in both the test and connected positions, there is no need to operate a separate linkage for testing.

The secondary disconnects are located on the side of the circuit breaker element, where they are shielded from accidental damage. They are of an extremely rugged design, in contrast to other designs, that employ light duty electronics-style disconnects, located in hidden or inaccessible locations. Alignment of the disconnects can be visibly observed, if desired, allowing positive verification of secondary integrity. This is a feature not possible with designs employing a disconnect underneath or behind the circuit breaker.

Auxiliary switch (circuit breaker mounted)
The auxiliary switch assembly is mounted on the vacuum circuit breaker with contacts for use in the circuit breaker control circuit and as spare contacts for other use. Normally, four auxiliary switch contacts, two NO (52a) and two NC (52b), can be wired out for purchaser use.

Mechanism-operated cell (MOC) switch
When required, 6, 12, 18 or 24 stages of a mechanism-operated cell (MOC) auxiliary switch can be mounted in the circuit breaker cell. This switch is operated by the circuit breaker mechanism, so that the switch contacts change state whenever the circuit breaker is closed or tripped. Normally, the MOC switch is operated only when the circuit breaker is in the connected position, but provisions for operation in both the connected and the test positions can be furnished. All spare MOC contacts are wired to accessible terminal blocks, as shown in Figure 26, for user connections.

The lower portion of Figure 26 shows four MOC switches (total 24 stages) plus the MOC operating linkage and four terminal blocks for MOC switch connections.

Truck-operated cell (TOC) switch
When required, 4, 8 or 12 stages of a truck-operated cell (TOC) switch can be mounted in the circuit breaker cell. The TOC switch contacts change state when the circuit breaker moves into or out of the connected position. All spare TOC contacts are wired to accessible terminal blocks, as shown in Figure 26, for user connections.

The upper portion of Figure 26 shows 12 stages of TOC switches plus two terminal blocks for TOC switch connections.
**Vacuum circuit breakers**

<table>
<thead>
<tr>
<th>Protected (load equipment)</th>
<th>Surge limiters recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid transformers</td>
<td>No</td>
</tr>
<tr>
<td>Dry type transformers</td>
<td></td>
</tr>
<tr>
<td>Standard BIL</td>
<td>Yes¹</td>
</tr>
<tr>
<td>5 kV 60 kV BIL</td>
<td>No</td>
</tr>
<tr>
<td>7 kV or 15 kV 95 kV BIL</td>
<td>No</td>
</tr>
<tr>
<td>Motors</td>
<td></td>
</tr>
<tr>
<td>Locked rotor current &lt; 600 A</td>
<td>Yes¹</td>
</tr>
<tr>
<td>Locked rotor current &gt; 600 A</td>
<td>No</td>
</tr>
<tr>
<td>Reactors</td>
<td>Yes</td>
</tr>
<tr>
<td>Capacitors</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 1: Surge limiter recommendations

Footnotes:
¹ Not necessary if surge capacitors or surge arresters are located at transformer or machine terminals.

**Surge limiters**

Type 3EF surge limiters are available for use in distribution systems to protect motors, transformers and reactors from the effects of voltage surges associated with circuit breaker operations. These limiters are not designed to protect equipment exposed to lightning surges, for which surge arresters should be applied.

The 3EF surge limiters prevent the development of excessive overvoltages that can result from multiple reignitions or virtual chopping. This is primarily of concern during the starting of motors and switching of some reactive loads.

In general, if the impulse capability (BIL) of the protected equipment matches that of the switchgear, no protection is needed due to the surges produced by the opening of the vacuum breaker. Since dry type transformers and rotating machines are generally of lower BIL, surge protection may be necessary.

Refer to Table 1 for minimum application recommendations for surge limiters.

**Siemens vacuum heritage**

The GMSG vacuum circuit breakers take full advantage of Siemens long history with vacuum interrupters for power applications. While early work was carried out in the 1920s, a successful vacuum interrupter could not be perfected until the high vacuum pump became available in the 1960s. Focused development effort began in 1969, culminating in the introduction of the type 3AF circuit breaker in 1976. The knowledge gained over years of application of this technology in the 3AF and 3AH circuit breakers is now available in the GMSG design. The advantages inherent in vacuum interruption are summarized as follows:

- **Ideal dielectric**
  
  In a vacuum, the dielectric strength across a contact gap recovers very rapidly allowing a small contact separation and an efficient interrupter design. The vacuum does not interact with the arc or its components as do other dielectrics.

- **Quiet operation**
  
  Interruption of currents by a vacuum circuit breaker is very quiet as compared to the loud report that accompanies interruptions in some other types of circuit breakers.

- **Low current chopping characteristics**
  
  The chrome-copper contact material used in Siemens interrupters limits chopping currents to a maximum of five amperes. This low value prevents the build-up of unduly high voltages and results in lower stress on the insulation of load equipment.
Vacuum circuit breakers

- No arc products vented to the atmosphere
  The sealed vacuum interrupter prevents venting of arc products to the atmosphere and prevents contamination of the contacts by the atmosphere. The metal vapor of the arc quickly recondenses on the surface of the contacts, although a small amount may recondense on the arc chamber wall or arc shield. The recondensing metal vapor acts as a "getter" and recaptures more molecules of certain gases that might be liberated during vaporization. This action tends to improve the vacuum in the interrupter during its operating life.

- Non-toxic interruption by-products
  The interruption process occurs entirely within the sealed vacuum interrupter. Even if an interrupter is physically broken, the arc products inside the interrupter are not toxic. In contrast, gas-filled interrupters produce toxic arc by-products, requiring special precautions in the event of a ruptured interrupter housing.

- Fewer components
  The vacuum interrupter pole construction is extremely simple and consists of only seven moving parts within the high voltage area and only two moving parts within the interrupter chamber. This means greater reliability and less maintenance with vacuum interrupters as compared to the greater number of parts in other type interrupters, such as gas or oil.

- Long interrupter life
  The interrupter has a long expected service life due to the careful selection of components. The chrome-copper contacts allow efficient interruption of both diffused and contracted arcs with very little contact erosion.

- Immunity to environment
  The capability of the vacuum interrupter to interrupt current or to withstand voltage is not directly affected by conditions external to the vacuum interrupter. High or low altitudes, hot or cold temperatures, moist or dry conditions, or heavy dust conditions, do not affect the conditions internal to the interrupter. Conditions external to the interrupter, however, could affect the overall system operation and should be considered in the specifications.

- Low maintenance
  Interrupter maintenance typically requires merely wiping dust or other atmospheric elements from the exterior, visually checking the contact wear indicator and periodic dielectric testing to confirm vacuum integrity.

- Lower force requirements
  The vacuum interrupter has a very low moving mass compared to that found in other interrupters. This allows a smaller, more compact stored energy operator leading to long life and low maintenance of the circuit breaker.
Vacuum circuit breakers

The arc drawn in the vacuum interrupter is not cooled. The metal vapor plasma is highly conductive and the resulting arc voltage is only 20 to 200 volts. This low arc voltage, combined with very short arcing times, produces only a very small arc energy in the vacuum interrupter, accounting for the long electrical life expectancy of the Siemens vacuum interrupter.

There are two types of arc shapes. Up to approximately 10 kA, the arc remains diffused. It takes the form of a vapor discharge and covers the entire contact surface. Diffused arcs are easily interrupted.

Radial magnetic field design interrupters are used for lower interrupting ratings. In radial magnetic field interrupters, when the arc current exceeds about 10 kA, the arc is constricted considerably by its own magnetic field and contracts essentially to a point arc. If the contracted arc is allowed to remain stationary, it overheats the contact at the arc roots to the point where molten metal vapor does not allow the dielectric to rebuild during the current zero and large magnitude currents cannot be interrupted. To overcome this, the contacts are designed in a cup shape with oblique slots, so that a self-generated field causes the arc to travel around the contacts. This prevents localized overheating when interrupting large magnitudes of short circuit current.

For high interrupting ratings, axial magnetic field design is employed. In this configuration, the current flow creates a magnetic field along the longitudinal axis of the interrupter. This field prevents constriction of the arc and this forces the arc to remain in diffuse mode. Since the arc remains in diffuse mode, localized overheating is avoided and contact erosion is held to low levels.

Vacuum interrupter principles

With Siemens GMSG vacuum circuit breakers, the chopping currents are held to five amperes or less. This is low enough to prevent the build-up of unduly high voltages, which may occur on switching of inductive circuits. The chrome-copper contact material keeps overvoltages to a minimum so special surge protection is not required in most applications.

When the contacts open, the current to be interrupted initiates a metal vapor arc discharge and current continues flowing through this plasma until the next current zero.

The arc is extinguished near the current zero and the conductive metal vapor recondenses on the contact surfaces and the arc chamber wall or arc shield within a matter of microseconds. As a result, the dielectric strength of the break recovers very rapidly and contact erosion is almost negligible.

Figure 27: Type 3AH3 operating mechanism
### Ratings

<table>
<thead>
<tr>
<th>Control voltages, ANSI C37.06</th>
<th>Control circuit voltage</th>
<th>Close coil</th>
<th>Trip coil</th>
<th>Spring charging motor</th>
<th>Footnotes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Range</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>Run (Avg.)</td>
</tr>
<tr>
<td>Close</td>
<td>Trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Vdc</td>
<td>19 - 28</td>
<td>14 - 28</td>
<td>5.8</td>
<td>17 / ----</td>
<td>----</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>36 - 56</td>
<td>28 - 56</td>
<td>2.9</td>
<td>11.4 / 30</td>
<td>8</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>100 - 140</td>
<td>70 - 140</td>
<td>1.0</td>
<td>4.8 / 7.4</td>
<td>4</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>200 - 280</td>
<td>140 - 280</td>
<td>0.5</td>
<td>2.1 / 4.2</td>
<td>2</td>
</tr>
<tr>
<td>120 Vac</td>
<td>104 - 127</td>
<td>104 - 127</td>
<td>0.9</td>
<td>----</td>
<td>6</td>
</tr>
<tr>
<td>240 Vac</td>
<td>208 - 254</td>
<td>208 - 254</td>
<td>0.4</td>
<td>----</td>
<td>3</td>
</tr>
</tbody>
</table>

**Footnotes:**
1. Current at nominal voltage.
2. Capacitor trip.
3. Value preceding slash (/) is the current for the standard trip coil with standard rating interrupting time. Value following (/) is current for optional trip coil with three-cycle interrupting time.
4. ---- means this selection is not available at this voltage.

---

<table>
<thead>
<tr>
<th>Type switch</th>
<th>Continuous current (A)</th>
<th>Control circuit voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120 Vac</td>
<td>240 Vac</td>
</tr>
<tr>
<td>Circuit breaker</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>TOC</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>MOC</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>

**Footnotes:**
1. Two contacts in series
2. All switch contacts are non-convertible
Ratings (modern "constant kA" basis)

<table>
<thead>
<tr>
<th>Circuit breaker type</th>
<th>Maximum design voltage (V)²</th>
<th>Voltage range factor (k)³</th>
<th>Withstand voltage levels</th>
<th>Continuous current⁴</th>
<th>Short-circuit (I)⁵, ⁶</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous current (I)⁵, ⁶</td>
<td></td>
<td></td>
<td>Short-time current (I)³ (three seconds)</td>
<td>Closing and latching (momentary)</td>
</tr>
<tr>
<td></td>
<td>kV rms</td>
<td>kV rms</td>
<td>Power frequency kV rms</td>
<td>Lightning impulse (BIL) kV crest</td>
<td>kA rms</td>
</tr>
<tr>
<td>5-GMSG-40-xxxx-104</td>
<td>4.76</td>
<td>1.0</td>
<td>19</td>
<td>60</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>5-GMSG-50-xxxx-130</td>
<td>4.76</td>
<td>1.0</td>
<td>19</td>
<td>60</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>5-GMSG-63-xxxx-164</td>
<td>4.76</td>
<td>1.0</td>
<td>19</td>
<td>60</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>7-GMSG-40-xxxx-104</td>
<td>8.25</td>
<td>1.0</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>15-GMSG-25-xxxx-65</td>
<td>15.0</td>
<td>1.0</td>
<td>36</td>
<td>95</td>
<td>1200, 2000</td>
</tr>
<tr>
<td>15-GMSG-40-xxxx-104</td>
<td>15.0</td>
<td>1.0</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>15-GMSG-50-xxxx-130</td>
<td>15.0</td>
<td>1.0</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
<tr>
<td>15-GMSG-63-xxxx-164</td>
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<td>1.0</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000FC</td>
</tr>
</tbody>
</table>

Table 4: Type GMSG circuit breaker ratings (new "constant kA" ratings basis)

These ratings are in accordance with:

- ANSI/IEEE C37.04-1999 standard rating structure for AC high-voltage circuit breakers
- ANSI/IEEE C37.06-2009 AC high-voltage circuit breakers rated on a symmetrical current basis - preferred ratings and related required capabilities for voltages above 1,000 volts
- ANSI/IEEE C37.09-1999 standard test procedure for AC high-voltage circuit breakers rated on a symmetrical current basis
- ANSI/IEEE C37.010-1999 application guide for AC high-voltage circuit breakers rated on a symmetrical current basis

Footnotes:

1. "xxxx" in type designation refers to the continuous current rating 1200 A, 2000 A or 3000 A, as appropriate. The 4000 A fan-cooled rating is achieved using a 3000 A circuit breaker, in combination with fan cooling as indicated in Footnote 4.
2. Maximum design voltage for which the circuit breaker is designed and the upper limit for operation.
3. K is listed for information purposes only. For circuit breakers rated on a "constant kA" ratings basis, the voltage range factor is 1.0.
4. 4000FC indicates that fan cooling is included in the switchgear structure for this rating. 4000 A rating is not available in outdoor equipment.
5. All values apply to polyphase and line-to-line faults.
6. Standard duty cycle is 0 - 0.3s - CO - 3 min. - CO.
7. Standard rating interrupting time is five-cycles (83 ms). Optional rated interrupting time of three-cycles (50 ms) is available (except with 24 Vdc tripping).
<table>
<thead>
<tr>
<th>Circuit breaker type</th>
<th>Interrupting time</th>
<th>Permissible tripping delay (y)</th>
<th>Max. sym. interrupting current (I)</th>
<th>% dc component</th>
<th>Short-time current (I) (three seconds)</th>
<th>Closing and latching (momentary)</th>
<th>Circuit breaker type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ms / cycles</td>
<td>Sec</td>
<td>kA rms sym</td>
<td>%</td>
<td>kA rms</td>
<td>Asymmetrical (1.55 x I) kA rms</td>
<td>Peak (2.6 x I) kA peak</td>
</tr>
<tr>
<td>5-GMSG-40-xxxx-104</td>
<td>83 / 5</td>
<td>2</td>
<td>40</td>
<td>47</td>
<td>40</td>
<td>62</td>
<td>104</td>
</tr>
<tr>
<td>5-GMSG-50-xxxx-130</td>
<td>83 / 5</td>
<td>2</td>
<td>50</td>
<td>47</td>
<td>50</td>
<td>78</td>
<td>130</td>
</tr>
<tr>
<td>5-GMSG-63-xxxx-164</td>
<td>83 / 5</td>
<td>2</td>
<td>63</td>
<td>47</td>
<td>63</td>
<td>98</td>
<td>164</td>
</tr>
<tr>
<td>7-GMSG-40-xxxx-104</td>
<td>83 / 5</td>
<td>2</td>
<td>40</td>
<td>47</td>
<td>40</td>
<td>62</td>
<td>104</td>
</tr>
<tr>
<td>15-GMSG-25-xxxx-65</td>
<td>83 / 5</td>
<td>2</td>
<td>25</td>
<td>47</td>
<td>25</td>
<td>39</td>
<td>65</td>
</tr>
<tr>
<td>15-GMSG-40-xxxx-104</td>
<td>83 / 5</td>
<td>2</td>
<td>40</td>
<td>47</td>
<td>40</td>
<td>62</td>
<td>104</td>
</tr>
<tr>
<td>15-GMSG-50-xxxx-130</td>
<td>83 / 5</td>
<td>2</td>
<td>50</td>
<td>47</td>
<td>50</td>
<td>78</td>
<td>130</td>
</tr>
<tr>
<td>15-GMSG-63-xxxx-164</td>
<td>83 / 5</td>
<td>2</td>
<td>63</td>
<td>47</td>
<td>63</td>
<td>98</td>
<td>164</td>
</tr>
</tbody>
</table>

GMSG 63 kA circuit breaker front view

GMSG 63 kA circuit breaker rear view
Ratings (historic "constant MVA" basis)

<table>
<thead>
<tr>
<th>Circuit breaker type</th>
<th>Nominal voltage class</th>
<th>Nominal three-phase MVA class</th>
<th>Maximum design voltage (V)</th>
<th>Continuous current</th>
<th>Voltage range factor (K)</th>
<th>Withstand voltage levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kV</td>
<td>MVA</td>
<td>kV rms</td>
<td>A rms</td>
<td>----</td>
<td>Power frequency K</td>
</tr>
<tr>
<td>5-GMSG-250-xxxx-97</td>
<td>4.16</td>
<td>250</td>
<td>4.76</td>
<td>1200, 2000</td>
<td>1.24</td>
<td>19</td>
</tr>
<tr>
<td>5-GMSG-350-xxxx-132</td>
<td>4.16</td>
<td>350</td>
<td>4.76</td>
<td>1200, 2000, 3000, 4000FC</td>
<td>1.19</td>
<td>19</td>
</tr>
<tr>
<td>7-GMSG-500-xxxx-111</td>
<td>7.2</td>
<td>500</td>
<td>8.25</td>
<td>1200, 2000</td>
<td>1.25</td>
<td>36</td>
</tr>
<tr>
<td>15-GMSG-500-xxxx-62</td>
<td>13.8</td>
<td>500</td>
<td>15.0</td>
<td>1200, 2000, 3000, 4000FC</td>
<td>1.30</td>
<td>36</td>
</tr>
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<td>15-GMSG-750-xxxx-97</td>
<td>13.8</td>
<td>750</td>
<td>15.0</td>
<td>1200, 2000, 3000, 4000FC</td>
<td>1.30</td>
<td>36</td>
</tr>
<tr>
<td>15-GMSG-1000-xxxx-130</td>
<td>13.8</td>
<td>1000</td>
<td>15.0</td>
<td>1200, 2000, 3000, 4000FC</td>
<td>1.30</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 5: Type GMSG circuit breaker ratings (historic "constant MVA" ratings basis)

These ratings are in accordance with:

- ANSI/IEEE C37.04-1979 standard rating structure for AC high-voltage circuit breakers rated on a symmetrical current basis
- ANSI C37.06-1987 AC high-voltage circuit breakers rated on a symmetrical current basis - preferred ratings and related required capabilities
- ANSI/IEEE C37.09-1979 standard test procedure for AC high-voltage circuit breakers rated on a symmetrical current basis
- ANSI/IEEE C37.010-1979 application guide for AC high-voltage circuit breakers rated on a symmetrical current basis.

Footnotes:

1. "xxxx" in type designation refers to the continuous current rating 1200 A, 2000 A or 3000 A, as appropriate. The 4000 A fan-cooled rating is achieved using a 3000 A circuit breaker, in combination with fan cooling as indicated in Footnote 4.
2. Maximum design voltage for which the circuit breaker is designed and the upper limit for operation.
3. K is the ratio of the rated maximum design voltage to the lower limit of the range of operating voltage in which the required symmetrical and asymmetrical interrupting capabilities vary in inverse proportion to the operating voltage.
4. 4000FC indicates that fan cooling is included in the switchgear structure for this rating. 4000 A rating is not available in outdoor equipment.
5. To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum design voltage and rated maximum design voltage, the following formula shall be used: Required symmetrical interrupting capability = rated short-circuit current (I) x [(rated maximum design voltage)/(operating voltage)]. For operating voltages below 1/K times maximum design voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short-circuit current. Within the limitations stated in ANSI/IEEE C37.04-1979, all values apply to polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in clause 5.10.2.3 of ANSI/IEEE C37.04-1979 apply.

6. Current values in this row are not to be exceeded even for operating voltage below 1/K times rated maximum design voltage. For operating voltages between rated maximum design voltage and 1/K times rated maximum design voltage, follow Footnote 5.

8. Current values in this row are independent of operating voltage up to and including rated maximum voltage.

9. Nominal three-phase MVA class is included for reference only. This information is not listed in ANSI C37.06-1987.

10. Standard duty cycle is O - 15s - CO.

11. Standard rating interrupting time is five-cycles (83 ms). Optional rated interrupting time of three-cycles (50 ms) is available (except with 24 Vdc tripping).

<table>
<thead>
<tr>
<th>Circuit breaker type¹</th>
<th>Short-circuit (at rated maximum design voltage) (I)</th>
<th>Interrupting time¹</th>
<th>Permissible tripping delay (y)</th>
<th>Rated maximum design voltage (V) divided by K (= V/K)</th>
<th>Max. sym. interrupting (K x I)⁷</th>
<th>Short-time current (I) (three seconds)</th>
<th>Closing and latching (momentary)</th>
<th>Circuit breaker type¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-GMSG-250-xxxx-97</td>
<td>29</td>
<td>83 / 5</td>
<td>2</td>
<td>3.85</td>
<td>36</td>
<td>36</td>
<td>58</td>
<td>97</td>
</tr>
<tr>
<td>5-GMSG-350-xxxx-132</td>
<td>41</td>
<td>83 / 5</td>
<td>2</td>
<td>4.0</td>
<td>49</td>
<td>49</td>
<td>78</td>
<td>132</td>
</tr>
<tr>
<td>7-GMSG-500-xxxx-111</td>
<td>33</td>
<td>83 / 5</td>
<td>2</td>
<td>6.6</td>
<td>41</td>
<td>41</td>
<td>66</td>
<td>111</td>
</tr>
<tr>
<td>15-GMSG-500-xxxx-62</td>
<td>18</td>
<td>83 / 5</td>
<td>2</td>
<td>11.5</td>
<td>23</td>
<td>23</td>
<td>37</td>
<td>62</td>
</tr>
<tr>
<td>15-GMSG-750-xxxx-97</td>
<td>28</td>
<td>83 / 5</td>
<td>2</td>
<td>11.5</td>
<td>36</td>
<td>36</td>
<td>58</td>
<td>97</td>
</tr>
<tr>
<td>15-GMSG-1000-xxxx-130</td>
<td>37</td>
<td>83 / 5</td>
<td>2</td>
<td>11.5</td>
<td>48</td>
<td>48</td>
<td>77</td>
<td>130</td>
</tr>
</tbody>
</table>

Footnotes:

1. To obtain the required symmetrical interrupting capability of a circuit breaker at an operating voltage between 1/K times rated maximum design voltage and rated maximum design voltage, the following formula shall be used: Required symmetrical interrupting capability = rated short-circuit current (I) x [(rated maximum design voltage)/(operating voltage)]. For operating voltages below 1/K times maximum design voltage, the required symmetrical interrupting capability of the circuit breaker shall be equal to K times rated short-circuit current. Within the limitations stated in ANSI/IEEE C37.04-1979, all values apply to polyphase and line-to-line faults. For single phase-to-ground faults, the specific conditions stated in clause 5.10.2.3 of ANSI/IEEE C37.04-1979 apply.

2. Current values in this row are not to be exceeded even for operating voltage below 1/K times rated maximum design voltage. For operating voltages between rated maximum design voltage and 1/K times rated maximum design voltage, follow Footnote 5.
## Ratings

### Table 6: Current transformers

<table>
<thead>
<tr>
<th>Ratio</th>
<th>60 Hz metering accuracy at burden</th>
<th>Relay class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B0.1</td>
<td>B0.5</td>
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</tbody>
</table>

#### Type MD toroidal standard accuracy

<table>
<thead>
<tr>
<th>Ratio</th>
<th>60 Hz metering accuracy at burden</th>
<th>Relay class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B0.1</td>
<td>B0.5</td>
</tr>
<tr>
<td>100:5</td>
<td>2.4</td>
<td>----</td>
</tr>
<tr>
<td>150:5</td>
<td>0.6</td>
<td>2.4</td>
</tr>
<tr>
<td>200:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>250:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>300:5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>400:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>500:5</td>
<td>0.3</td>
<td>0.3</td>
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<tr>
<td>600:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>75:5</td>
<td>2.4</td>
<td>4.8</td>
</tr>
<tr>
<td>100:5</td>
<td>1.2</td>
<td>2.4</td>
</tr>
<tr>
<td>150:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>200:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>250:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>300:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>400:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>500:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>600:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>75:5</td>
<td>2.4</td>
<td>4.8</td>
</tr>
<tr>
<td>100:5</td>
<td>1.2</td>
<td>2.4</td>
</tr>
<tr>
<td>150:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>200:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>250:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>300:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>400:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>500:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>600:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>75:5</td>
<td>2.4</td>
<td>4.8</td>
</tr>
<tr>
<td>100:5</td>
<td>1.2</td>
<td>2.4</td>
</tr>
<tr>
<td>150:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>200:5</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>250:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>300:5</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>400:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>500:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>600:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
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</table>

#### Type MDD toroidal special accuracy

<table>
<thead>
<tr>
<th>Ratio</th>
<th>60 Hz metering accuracy at burden</th>
<th>Relay class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B0.1</td>
<td>B0.5</td>
</tr>
<tr>
<td>1200:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>1500:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>2000:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>2500:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>3000:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>4000:5</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

---

**Footnotes:**

1. One-second through current and momentary current are equal to the ratings of the associated circuit breakers.
2. Exceeds ANSI C37.20.2 accuracy limit.
3. Multi-ratio current transformers available. The accuracy ratings shown apply only to the full secondary winding.
## Ratings

<table>
<thead>
<tr>
<th>Voltage class</th>
<th>Ratio</th>
<th>Accuracy class</th>
<th>VA thermal rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 kV</td>
<td>2400 / 120</td>
<td>0.3, 1.2</td>
<td>500</td>
</tr>
<tr>
<td>5 kV</td>
<td>4200 / 120</td>
<td>0.3, 1.2</td>
<td>500</td>
</tr>
<tr>
<td>5 kV</td>
<td>4800 / 120</td>
<td>0.3, 1.2</td>
<td>500</td>
</tr>
<tr>
<td>15 kV</td>
<td>7200 / 120</td>
<td>0.3, 0.3, 1.2</td>
<td>1000</td>
</tr>
<tr>
<td>15 kV</td>
<td>8400 / 120</td>
<td>0.3, 0.3, 1.2</td>
<td>1000</td>
</tr>
<tr>
<td>15 kV</td>
<td>12000 / 120</td>
<td>0.3, 0.3, 1.2</td>
<td>1000</td>
</tr>
<tr>
<td>15 kV</td>
<td>14400 / 120</td>
<td>0.3, 0.3, 1.2</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 7: Voltage transformers

GMSG circuit breaker front view

GMSG circuit breaker rear view
### Dimensions

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions in inches (mm)</th>
<th>Weight in lbs (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height</td>
<td>Width</td>
</tr>
<tr>
<td>Indoor GM-SG</td>
<td>95.3</td>
<td>36.0</td>
</tr>
<tr>
<td></td>
<td>(2419)</td>
<td>(914)</td>
</tr>
<tr>
<td>Shelter-Clad single-aisle</td>
<td>114.8</td>
<td>36.0</td>
</tr>
<tr>
<td>SGM-SG</td>
<td>(2915)</td>
<td>(914)</td>
</tr>
<tr>
<td>Aisle-less non-walk-in</td>
<td>113.6</td>
<td>36.0</td>
</tr>
<tr>
<td>OGM-SG</td>
<td>(2886)</td>
<td>(914)</td>
</tr>
</tbody>
</table>

Table 8: Cubicle dimensions per vertical section

<table>
<thead>
<tr>
<th>Circuit breaker type</th>
<th>Continuous current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>5-GMSG-40</td>
<td>440 (200)</td>
</tr>
<tr>
<td>5-GMSG-250</td>
<td></td>
</tr>
<tr>
<td>5-GMSG-50</td>
<td>455 (206)</td>
</tr>
<tr>
<td>5-GMSG-350</td>
<td></td>
</tr>
<tr>
<td>5-GMSG-63</td>
<td>809 (368)</td>
</tr>
<tr>
<td>7-GMSG-40</td>
<td>455 (206)</td>
</tr>
<tr>
<td>7-GMSG-500</td>
<td></td>
</tr>
<tr>
<td>15-GMSG-25</td>
<td>430 (195)</td>
</tr>
<tr>
<td>15-GMSG-500</td>
<td></td>
</tr>
<tr>
<td>15-GMSG-40</td>
<td>445 (202)</td>
</tr>
<tr>
<td>15-GMSG-750</td>
<td></td>
</tr>
<tr>
<td>5-GMSG-50</td>
<td>460 (209)</td>
</tr>
<tr>
<td>5-GMSG-1000</td>
<td></td>
</tr>
<tr>
<td>15-GMSG-63</td>
<td>819 (372)</td>
</tr>
</tbody>
</table>

Table 9: GMSG circuit breaker weight in lbs (kg)

Footnotes:
1. Weight does not include circuit breakers, add separately from Table 9.
2. Weight estimates are for circuit breaker only. Add 75 lbs (34 kg) if shipped separately packaged.
3. Weight and dimensions are approximate.
4. Add 6" (152 mm) to each end of lineup for aisle extension 12" (304 mm) total.
5. 72" (1829 mm) aisle space recommended allows room for interchange of circuit breakers. Minimum aisle space required for handling circuit breaker with lift truck is 65" (1651 mm). Minimum aisle space required if all circuit breakers are at floor level is 55" (1397 mm).
6. Add for roof overhang:
   Rear (cable side):
   - Non-walk-in: 4.25" (108 mm)
   - Shelter-Clad: 4.25" (108 mm).
   Front (drawout side):
   - Non-walk-in: 3.9" (99 mm)
   - Shelter-Clad: 2.2" (56 mm).
7. If indoor switchgear is installed on a raised housekeeping" pad, the pad must not extend further than 3" (75 mm) from the front of the switchgear to avoid interference with the use of the portable lift truck.
8. Approximate circuit breaker dimensions in inches (mm) (width X depth X height):
   - 32" (813 mm) X 39" (991 mm) X 36" (914 mm).
   If packed for shipment separate from switchgear:
   - 42" (1067 mm) X 47" (1194 mm) X 43" (1092 mm).
Dimensions

Figure 28: GM-SG stacking versatility

Footnotes:
2. No rollout auxiliaries allowed in upper cell (C or D) if lower cell (B) has 3000 A circuit breaker. If 3000 A circuit breaker is located in upper cell (A), one rollout auxiliary may be located in lower cell F.
3. Auxiliary cells (C, D, E or F) may each contain one rollout (except as indicated in Footnotes 2 and 5).
4. Fuse rollout for stationary CPT must be located in lower rollout cell F, if CPT is located in rear or is remote. If CPT is located in lower auxiliary cell (E and F), fuse rollout is located in upper auxiliary cell.
5. For fan-cooled 4000 A rating, circuit breaker (3000A self-cooled, 4000 A fan-cooled) may be located in upper cell (A) with fan cooling in cell E or may be located in lower cell (B) with fan cooling in cells C and D.
6. Stacking arrangements are available as shown. Total circuit breaker loading in a vertical unit may not exceed main bus rating. Consult Siemens for specific application assistance regarding total load limits in each unit or refer to ANSI/IEEE C37.20.2.
Dimensions

Figure 29: Side views

Type GM-SG indoor switchgear

Type OGM-SG non-walk-in outdoor switchgear

Type SGM-SG Shelter-Clad single-aisle outdoor switchgear

Dimensions
After switchgear is leveled and permanently welded or bolted in place, apply asphalt or epoxy grout between the foundation and the cubicle floor. Slope the grout so the circuit breaker can easily be wheeled in and out of the cubicle.

When sill channels are not used, customer’s floor must not project above mounting surface of channels at any point within the floor area covered by the switchgear cubicles.

Sill channels and anchor bolts furnished by customer unless covered by contract.

Conduit height not to exceed 1.0” above floor line. Conduits should be sealed to prevent arcing byproducts from entering conduit system.

**Maximum area for cables from:**

**Area A** 20.75” x 8.5” deep (527 mm x 216 mm)
For cables from either bottom circuit breaker out top (when top circuit breaker also exits top) or top circuit breaker out bottom (when bottom circuit breaker also exits bottom)

**Area B** 20.75” x 8.5” deep (527 mm x 216 mm)
For cables from either top circuit breaker out top (when bottom circuit breaker also exits top) or bottom circuit breaker out bottom (when top circuit breaker also exits bottom)

**Area C** 26.0” x 19.2” deep (660 mm x 486 mm)
For cables from either nearest circuit breaker out top (when only this circuit breaker exits top) or nearest circuit breaker out bottom (when only this circuit breaker exits bottom).

Floor must be level 48.0” in front of switchgear to allow proper operation of circuit breaker lift truck.

Allow 30.0” clearance for door swing on left hand end.

Allow 6” for circuit breaker withdrawal (each side)

Allow 72.0” (recommended) for circuit breaker withdrawal

Minimum drawout space for circuit breaker at floor level is 55.0.
Side views

Figure 31: Section arrangement
Footnotes:
1. Bus tie circuit breaker (1200 A, 2000 A, 3000 A or 4000 A) may be located in upper or lower compartment, as desired.
2. Adjacent unit must normally have auxiliary compartment at same level as bus tie circuit breaker to accommodate transition bus. Consult Siemens if auxiliary compartment at same level as bus tie circuit breaker is not available.
3. Units with 1200 A or 2000 A bus tie circuit breakers may have a feeder circuit breaker 1200 A or 2000 A located in the same unit.

4. Units with 3000A or 4000A bus tie circuit breaker in the lower cell must have a vented auxiliary compartment (no rollout auxiliaries) above the circuit breaker. Units with 3000 A or 4000 A bus tie circuit breaker in upper cell may have one rollout auxiliary in cell F.
5. Maximum main bus size 4000 A (self-cooled).
6. A = upper compartment for circuit breaker or non-rollout auxiliaries. B = lower compartment for circuit breaker or non-rollout auxiliaries. C = VTs. D = VTs or CPTs. E = VTs. F = VTs. CPT or rollout fuses for stationary CPT.