ADVAC®

Advanced Design Vacuum Circuit Breakers

OEM Components

Product Description and Technical Information

Bulletin No. TB3.2.8 - 1A

ABB Power T&D Company Inc.

ADVAC

Advanced Design Vacuum Circuit Breaker

CONTENTS

ADVAC - Advanced Design Vacuum Circuit Breakers

Introduction

The ADVAC OEM program . . . the *right* choice for your business

The power distribution business is competitive and demanding. Switchgear customers insist on high quality products with increasingly fast deliveries and competitive prices. Owners and operators expect metal-clad switchgear to meet demanding requirements for safety, ease of operation, and minimum maintenance over a long life. They expect the latest technology to help them meet these immediate needs, while also anticipating changes in industry standards, operational resources, and other critical areas.

To meet these requirements, manufacturers of complex, custom switchgear must have a dependable supplier of circuit breakers and components. They need value, flexibility, quality and a partner with the technology to help them - and their customers - succeed in today's business environment.

The Supplier of Choice is ABB

ADVAC circuit breakers and metal-clad switchgear components offer the benefits of the latest technology in medium voltage vacuum circuit breakers. A modular system of switchgear building blocks provides superior value, flexibility and quality to switchgear assemblers. And the ABB OEM program is founded on a commitment to outstanding customer service and the best reputation in the industry for long term product support.

The Latest Technology

ADVAC advanced design vacuum circuit breakers feature the latest technology in vacuum interrupters and operating mechanisms, resulting in outstanding reliability and maintainability. The incredibly simple mechanism, the first designed specifically for modern vacuum interrupters, is the only new mechanism from any supplier in well over a decade.

Superior Value

ADVAC OEM cells provide switchgear manufacturers with the best value in the industry — with features that create the ability to focus on areas of optimum value added, plus one-stop shopping from a complete library of standard, economical building blocks. For example, circuit breaker compartments are shipped with guide rails, shutters, primary and secondary disconnects, and all other critical components factory-installed and aligned. Thoughtful features add more value: ample room for terminal blocks and secondary wiring; grounded steel paths for control wiring inside the compartment; secondary leads pre-wired to terminal blocks, and more.

ADVAC circuit breakers and OEM cells provide switchgear assemblers the best value in the industry.

ADVAC circuit breakers are automatically tested and cycled 300 operations prior to shipment.

Flexibility

A wide array of primary compartment modules can be stacked in a variety of arrangements to meet virtually any application, with compact footprints that reduce floor space and installation costs. Top or bottom entry of both primary and control wiring add versatility. The wide choice of primary modules, coupled with ABB value-added features and quick bolt-together construction, create the flexibility to quickly order and receive building blocks that can be efficiently configured to meet shorter lead times for complete systems. This means greater flexibility for you - and for your customers.

Quality You Can Depend On

The ADVAC breaker and switchgear components have been subjected to rigorous ANSI design tests. Rugged, self-supporting bolted module construction provides consistent alignment and enables easy assembly and adjustment. Rigid hem-bending provides a total of four layers of steel where adjacent modules are bolted together. Modules are suitable for use in switchgear that has been seismically certified for UBC Zone 4. And each ADVAC circuit breaker is automatically tested and cycled 300 operations prior to shipment.

You can count on ABB for technology leading products – plus the value, flexibility and quality you need for your business.

PRODUCT DESCRIPTION

ADVAC
Advanced Design Vacuum Circuit Breaker

ADVAC - Advanced Design Vacuum Circuit Breakers

Product Description

ADVAC Circuit Breakers

The ADVAC series of vacuum circuit breakers is a complete line of ANSI-rated circuit breakers offering power distribution system customers the advantages of the latest vacuum circuit breaker technology — technology that reduces ownership costs through improved reliability and maintainability.

Ratings

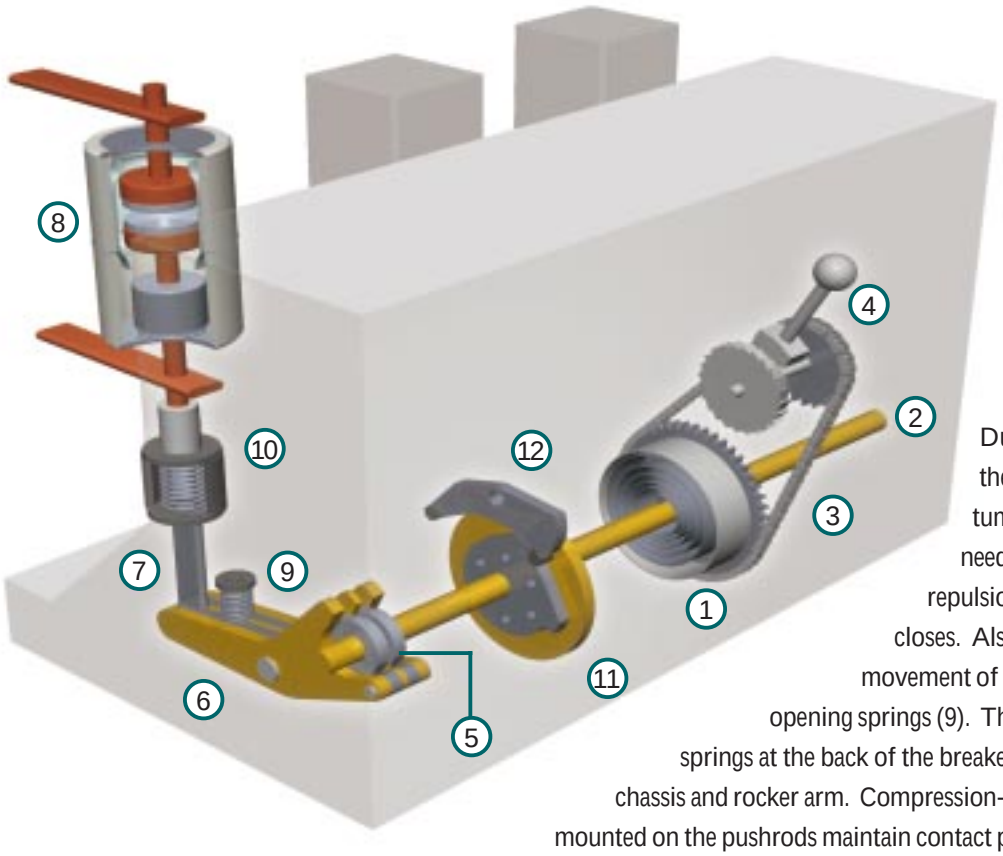
ADVAC is available in the full range of ANSI ratings through 15 kV, with interrupting ratings to 1000 MVA and continuous currents through 3000 A (self-cooled). A complete table of breaker types and ratings is provided in the Reference Section.

Operating Mechanism

ADVAC uses a simple, front-accessible stored-energy operating mechanism designed specifically for use with vacuum technology. This provides the benefits of dependable vacuum interrupters with advanced contact design and proven reliability, without the complexity of mechanisms and linkages found in previous generation circuit breakers.

The unique ADVAC mechanism uses a single toroidal spring (1) mounted on a drive shaft (2) to rotate the shaft in the same direction during opening and closing. The spring can be charged manually via the chain drive (3) and ratchet wheel (4) , or electrically by the spring charging gear motor (not shown in this view). Three sets of precision cams (5), one for each phase, are mounted on the drive shaft. The cams operate moving stems on vacuum interrupters (8) through insulating pushrods (7) and direct-acting rocker arms (6) that convert the rotational force to linear force, accelerating and decelerating interrupter contacts at optimum speeds during both opening and closing operations.

The cam shape is designed for the small contact travel required by vacuum interrupters, and when used with the toroidal spring, this provides much more efficient movement than the complex linkages and springs used on conventional breakers. Cam design is critical, as it determines proper contact speed and momentum. This is an important advantage because it avoids excessive force that could cause premature wear on both the contacts and the operating mechanism.



ADVAC Operating System

During closing, the shaft rotates the cams 270˚ to build momentum for the proper closing force needed to counteract magnetic repulsion of contacts as the breaker closes. Also during closing, upward movement of the rocker arm charges primary opening springs (9). These are compression type springs at the back of the breaker, mounted between the chassis and rocker arm. Compression-type wipe springs (10) mounted on the pushrods maintain contact pressure once the rocker arms are locked in the closed position. The cams are stopped precisely at the 270˚ position by a "stop disk" (11) on the rotating shaft. The stop disk locks main shaft rotation, cams, rocker arms, pushrods and contacts in the closed position.

A trip signal releases a trip latch (12), which in turn allows the shaft to complete its rotation back to the full 360˚ position. Shaft movement is aided by the remaining charge on the toroidal spring. However, the principle operating force is provided by the primary compression springs on each phase, which are now free to discharge because of the release of the main shaft, rocker arms and pushrod. A third, but minimal opening force is provided by the preloaded wipe (compression) springs on the pushrods, although these springs are primarily used to maintain contact pressure.

This simple concept uses only a small fraction of the moving parts found in conventional breakers, resulting in maximum reliability over a longer life — with added savings from easy, infrequent maintenance.

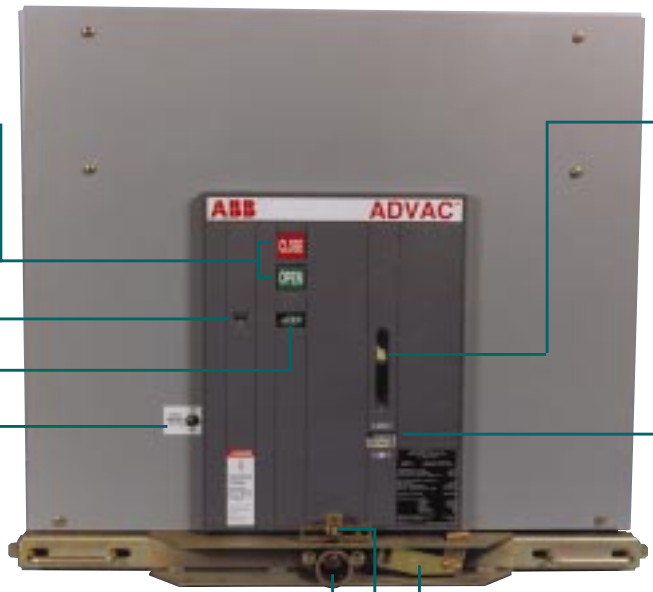
Control System

Control features of the ADVAC breaker emphasize convenience, maintainability and flexibility. Charge, close and trip functions can be accomplished both electrically and manually. All manual functions can be performed with great ease at the front of the breaker. Standard operator control features are shown below.

Control flexibility is the result of a wide range of standard and optional features, including independently selectable voltages for electric charge, close and trip functions. Eight auxiliary switch contacts (4 “a”, 4 “b”) are mounted on-board and wired through the automatic secondary disconnect. A single schematic diagram (page 48) shows all standard control features, regardless of control voltage.

Several options are available with an additional secondary disconnect, to offer a high degree of flexibility in control system design. Options include dual isolated shunt trip coils, a direct-acting undervoltage release, and nine extra on-board contacts for a total of 17 auxiliary contacts (9 “a”, 8 “b”). Since all auxiliary contacts are on-board, they operate whenever the breaker operates in either Test or Connected positions.

Front view of ADVAC circuit breaker



Manual open and close push buttons

Non-resettable operations counter

Open/closed indicator

Charging motor disconnect switch

Racking access port

Manual spring charge port

Spring charge status indicator

Cell locking tabs and handles

Racking release lever

Racking padlock provision for lockout and safety procedures

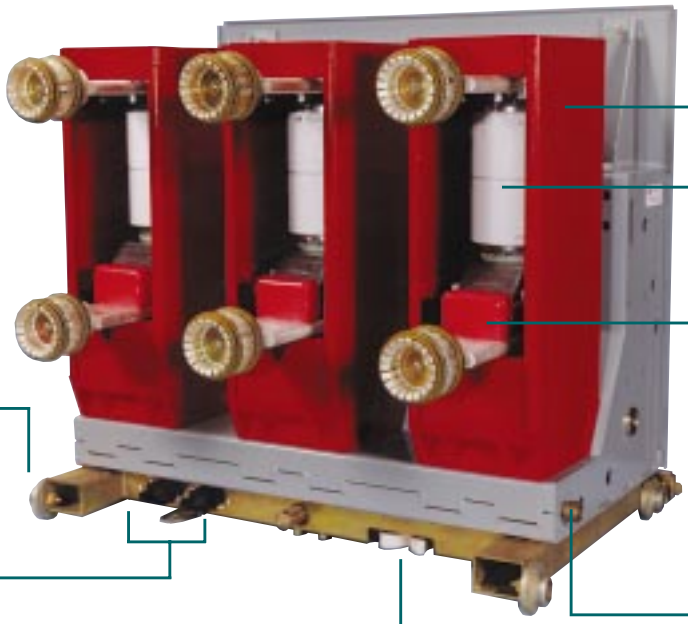
The ADVAC control system reduces ownership costs through greatly simplified inspection and maintenance procedures. The entire operating mechanism and its control components are front accessible. Modular construction and the use of common components result in fewer spare parts, and the entire control package is removable for easy maintenance and functional changes.

Extensive on-board auxiliary contacts eliminate cell-mounted mechanism operated (MOC) auxiliary switches and related mechanical linkages that often require adjustment on conventional breakers.

A solid state control device replaces the conventional anti-pump relay. This improves reliability and eliminates field adjustments.

ADVAC breaker with front panel removed shows convenient access to the simple operating mechanism and control components.

Rear view of ADVAC circuit breaker



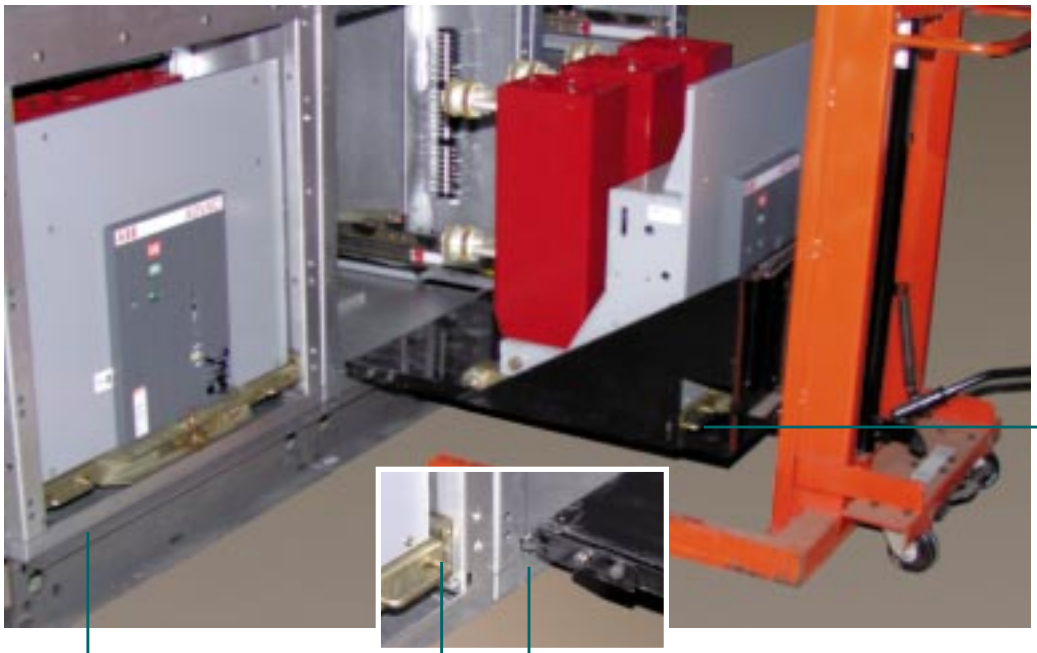
Cell Interface and Racking

The ADVAC breaker-cell interface is designed for maximum operator safety by providing three-position, closed door racking with self-aligning, fully automatic primary and secondary contacts. The racking system is integral to the breaker, so moving parts can be inspected and maintained outside the breaker compartment and away from energized primary and secondary circuits. ADVAC breakers have self-contained wheels for convenient floor maneuvering. Breakers are easily inserted and withdrawn from compartments using a lift truck with positive cell docking for safety.

The simple racking system is operated manually using a standard 16 mm socket drive. Each of the three distinct compartment positions has a positive stop. Deliberate operator action is required to release the breaker for racking from any of these positions.

- Disconnected — Primary and Secondary (control) contacts disengaged
- Test — Primary contacts disengaged, Secondary contacts engaged for electrical operation
- Connected — Primary and Secondary contacts engaged and ready for operation

ADVAC breaker on lift truck



The racking system also includes all interlocks necessary for proper sequencing and operation. An ADVAC breaker cannot be racked while contacts are closed, a breaker cannot be closed when in an intermediate position, and an improperly rated breaker cannot be inserted into a cell. The breaker also cannot be moved to the Connected position unless secondary contacts are engaged. A standard padlock provision can be used to support lock-out and tag-out procedures by preventing racking in any position.

Since the racking system is fully automatic, engagement and disconnect of both primary and secondary contacts are completely sequenced and driven by the racking operation, even with the compartment door closed. No manual intervention is required.

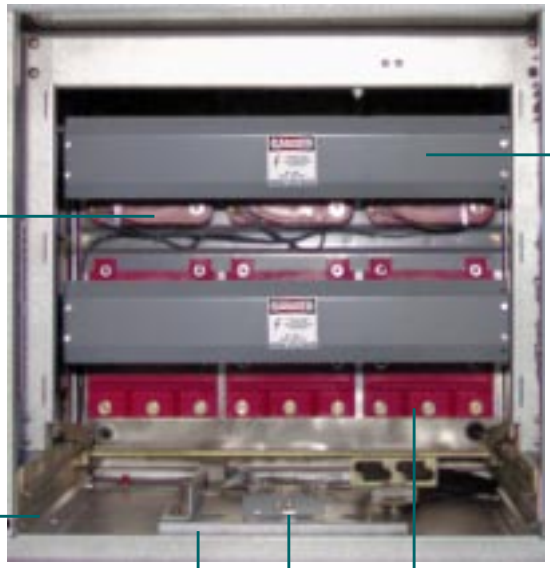
Primary shutters automatically cover primary contacts when the breaker is not in the Connected position. The shutters, which may be of grounded metal or insulating polycarbonate material, are actuated simultaneously from both sides of the breaker for smooth, balanced operation that eliminates binding. Metallic shutters are grounded by dedicated wiring rather than through mechanical linkages. An interlock prevents accidental opening of the shutters.

Current Transformers

Each primary compartment has room for up to four standard accuracy current transformers (CTs) per phase.

Dual Guide Rails

ADVAC breakers lock securely into cells on both sides. Dual guide rails and self-aligning primary and secondary contacts assure smooth, consistent racking, and support the breaker firmly during peak short circuit conditions.



Primary Shutters

Shutters automatically cover primary contacts when the breaker is not in the Connected position. Shutter closing is mechanically forced by breaker withdrawal, rather than relying on springs or gravity.

Circuit Breaker Grounding

A stationary ground bar engages the breaker grounding contact in the Disconnected position and is continuous between the Disconnected and Connected positions.

Interference Blocking

The compartment has interfence blocking to prevent insertion of improperly rated breakers.

Primary Supports

Primary contacts and CTs are supported by standard glass-polyester or optional porcelain bushings.

TOC Actuator

Switch contacts are actuated by the front panel as the breaker moves in and out of the Connected position.

Terminal Block Mounting Space

Ample room is provided for connections to secondary wiring from circuit breakers, current transformers and other devices.

Secondary Disconnect

A single 25-pin secondary disconnect provides ample connection capacity for standard control circuits. An optional dual disconnect (shown) accommodates optional control features. Female contacts reside in the cell so that potentially energized control contacts are recessed.

Position Indicator

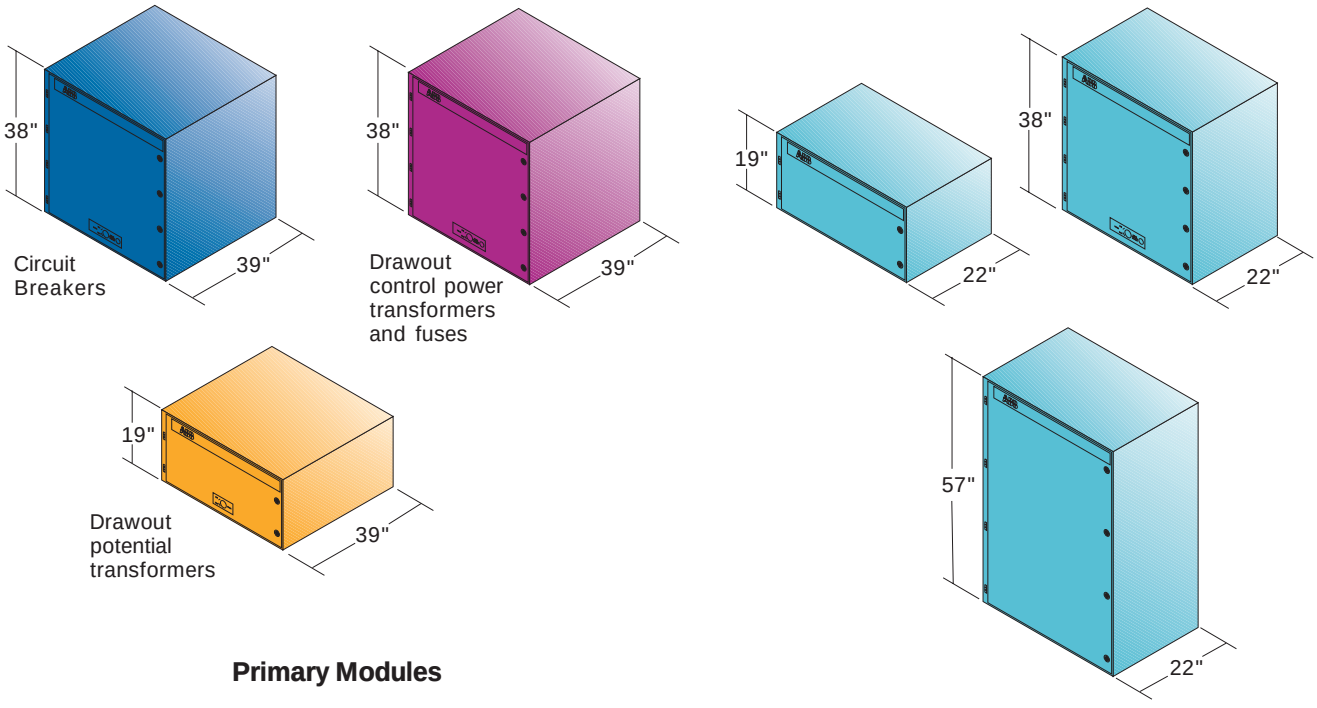
A position decal indicates breaker position by alignment with the front panel of the breaker.

Modular Construction

Metal-clad switchgear systems with ADVAC circuit breakers are assembled from a complete set of rugged, stackable circuit breaker and auxiliary equipment modules. Primary modules are constructed from Galvalume® pre-coated steel for superior corrosion resistance. Hem-bending is used to form a rigid, self-supporting structure. In addition to its outstanding structural benefits, hem-bending results in rounded steel edges that greatly reduce the risk of injury during shop handling and assembly, as well as during field inspections and maintenance. Precision fabrication equipment and advanced construction techniques result in high quality, properly aligned modules that support efficient field installation and commissioning, and provide consistent interchangeability of drawout assemblies with common ratings. Modern bolted construction also greatly reduces the down time and costs associated with system changes and expansions.

Module Types

A complete set of primary and low voltage modules are available. All modules are 36 inches wide. Module dimensions shown below do not include doors.

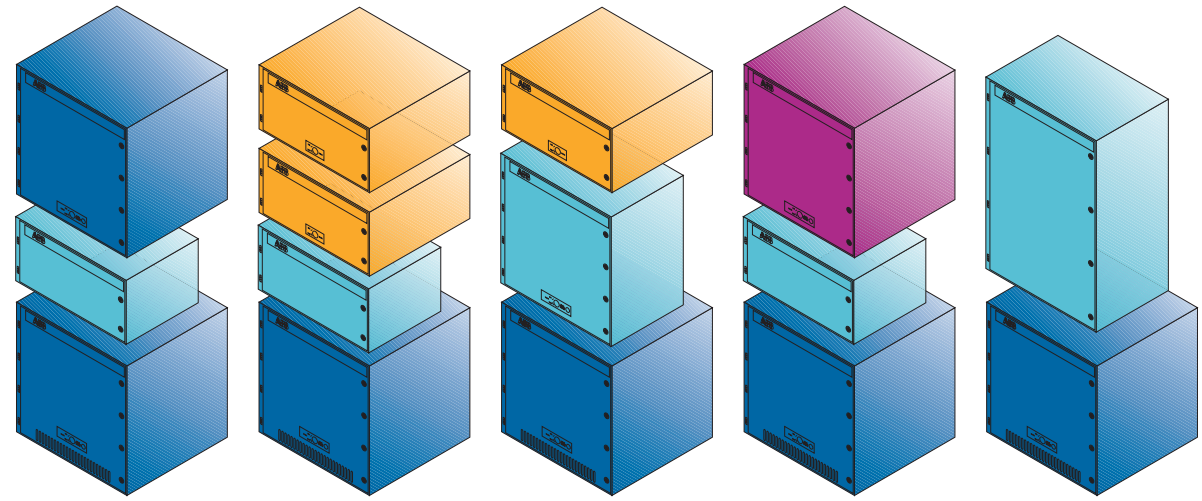


Primary Modules

Low Voltage Modules

Flexible Arrangements

ADVAC circuit breakers and metal-clad components offer a variety of one-high and two-high switchgear configuration options as shown below. Modules are stackable to a total height of 95 inches.



1200 A - 2000 A
(2000 A in bottom only)

Any breaker rating

Superior value

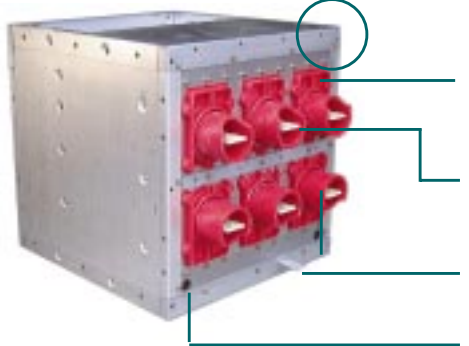
In addition to the structural advantages of ABB modules, primary compartments are shipped completely assembled and aligned in the factory. Pre-installed equipment includes guide rails, primary bushings and contacts, ground contact bar, and secondary disconnects pre-wired to terminal blocks. For circuit breaker modules, the automatic primary shutters are also installed, and the interference block is set for the cell current rating.

Modules also include predetermined routings for secondary wiring in grounded steel channels. Ample room for terminal blocks is provided on side panels. Grommeted “knock-outs” and convenient conduit locations facilitate control wiring to upper and lower modules. In ABB switchgear designs, all wiring to adjacent vertical sections is routed through isolated low voltage modules.

TOC switches and Kirk® Key interlock mounting provisions are shipped as kits for easy field installation.

Module Assembly

Modules are enclosed by sheet steel on five sides, and are ready for immediate assembly to adjacent units. Modules are designed to be bolted together at frequent intervals using high quality hardware, with 3/8-inch bolts penetrating four layers of steel at each point.



Circuit breaker module (rear view)

Each module has bolt provisions for connection to upper or lower modules in the same vertical section, connection to modules in adjacent vertical sections, and attachment of primary bus barriers and rear cable compartments fabricated by the switchgear assembler.

Doors

All modules have front flanges with hole patterns suitable for installing bolted door hinges. Detailed information on recommended door construction, ventilation, instrument mounting space, weight limits, and access ports for breaker racking, are available for OEM reference.

Modern microprocessor technology enables consolidation of multiple protective and instrumentation functions for all phases into fewer devices. Therefore, most relays and controls can be mounted on isolated low voltage compartment doors. In some cases, the use of discrete relays or extensive protection systems dictate mounting instruments on primary compartment doors. In these situations, 10-inch front frame extensions provide adequate depth for virtually all door-mounted instruments. These frame extensions match the flange hole pattern for easy bolting in place. Extensions are available from ABB, or they can be fabricated by the switchgear assembler using standard ABB frame extension drawings for reference.

With appropriate low voltage compartments, the primary modules generally stack to a total height of 95 inches in two-high breaker configurations. Lower profile switchgear can be achieved for special applications where a one-high breaker configuration is suitable.

Circuit Breaker Modules

Operational features of the ADVAC circuit breaker modules are described in “Cell Interface and Racking”.

Modules rated at 1200 amps are stackable as shown in the “Flexible Arrangements” section, and upper and lower modules are similar. Upper modules require top cover plates which are available from ABB or readily fabricated by the switchgear assembler. Modules rated at 2000 and 3000 amps have an elevated breaker racking platform with a venting provision at the front of the cell. This allows air to circulate under the breakers and eliminates the need for vented doors.

All circuit breaker modules are suitable for top or bottom entry of control wiring. Primary contacts are fabricated from solid copper.

In addition to a choice of 1200, 2000 or 3000 amp cells, important options include the choice between standard glass-polyester primary supports and optional porcelain bushings (standard on 3000 A cells), grounded metal or optional insulated polycarbonate shutters, and single or dual secondary disconnects. Other cell-mounted options include TOC switches (truck operated contacts) and Kirk Key interlock mounting provisions.

2000A Module with optional porcelain contact supports (shutters removed)

Rear view of 3000A Module with standard porcelain contact supports

TOC Switches

TOC switches indicate when the circuit breaker is in the Connected position and primary contacts are engaged. The TOC switch consists of a mechanical switch actuated by the ADVAC breaker panel on insertion to the Connected position, and a four-pole (2 “a”, 2 “b”), eight-pole (4 “a”, 4 “b”) or twelve-pole (6 “a”, 6 “b”) electrical contact assembly driven by the mechanical switch. The electrical contacts and terminals are installed in an isolated low voltage compartment mounted over the breaker compartment. Optional TOC switches are shipped as kits for easy field installation.

Kirk Key Interlocks

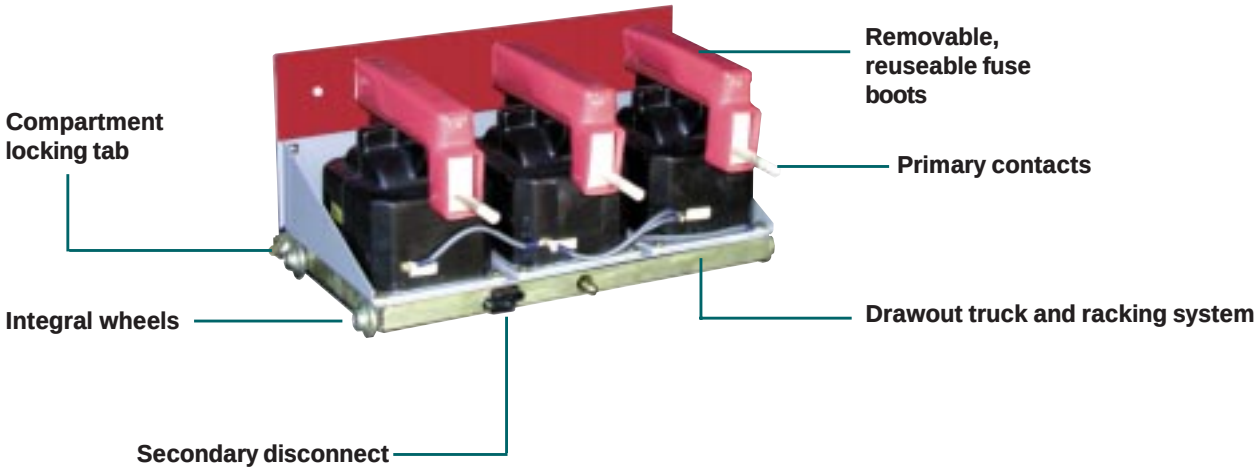
Kirk interlocks are often used as safety measures to prevent inserting a circuit breaker unless a specified key is present, assuring that equipment is operated in a precise sequence. This feature is typically used to mechanically prevent access to circuits energized by a remote source, or to prevent the simultaneous connection of unsynchronized sources. Optional Kirk Key interlock provisions enable separate installation of single or double Kirk interlocks. Kirk mounting provisions are shipped as kits for field installation. Kirk locks are not included in mounting provision kits, and must be ordered separately.

Auxiliary Primary Equipment

Potential Transformer (PT) Modules

PT modules accommodate industry-leading type VIY and VIZ switchgear style potential transformers from ABB. Each module accepts up to three transformers with line-to-line (L-L) or line-to-ground (L-G) connections, and is supplied with the drawout truck, PT mounting hardware, fuse clips and reusable fuse boots. PTs and fuses are supplied by the switchgear assembler. The modules include recessed primary "snuffer" arc-quenching contacts, dual guide rails, and a racking system that uses the same accessories as the circuit breaker modules. The snuffer contacts interrupt magnetizing currents and are recessed to prevent incidental contact with energized circuits. Secondary contacts are automatically sequenced and interlocked. PTs are automatically grounded on withdrawal to discharge residual current.

PT drawout assembly with three transformers



Control Power Transformer (CPT) Modules

CPT modules provide convenient mounting and operation of single phase control power transformers in ratings to 15 kVA. The modules include primary and secondary disconnects, dual guide rails, and a racking system that uses the same accessories as circuit breaker modules. Secondary contacts are sequenced and interlocked. ABB drawings indicate CPT manufacturer compatibility, and drawout trucks with appropriate CPT and fuse mounting hardware are included with the modules.

Drawout Fuse Modules

Fuse modules accommodate up to three primary fuses for use with fixed-mount control power transformers and other primary voltage level circuit protection. Fuse modules are supplied with drawout trucks and equipped with primary contacts, fuse mountings, and fuse clips for current limiting fuses.

Auxiliary equipment drawer in Disconnected position

Note: ABB Auxiliary equipment modules do not include transformers or fuses. These components are normally supplied by the switchgear assembler.

Low Voltage Modules

The ABB design concept for metal-clad switchgear is to locate protection and control devices in dedicated low voltage (LV) compartments. This completely isolates and segregates control equipment and circuits from high voltage areas, providing maximum safety for operations and maintenance personnel working on switchgear controls.

Most control devices are mounted on LV module doors for easy readability and convenient access. Devices that do not require immediate access, such as auxiliary relays, transducers, and terminal blocks, are mounted inside the LV compartments.

The LV compartments are available in 19- 38- and 57-inch height modules. These modules feature the same rugged construction as primary modules, and are supplied with grommets for cross-panel wiring, as well as cut-outs for wiring to upper and lower primary modules in the same vertical section. Provisions are also made for customer wiring entry.

ABB standard LV modules have a depth of 22 inches, and provide ample room for control devices and wiring. The compartment depth is well-suited for easy access for on-going inspections and maintenance. Low voltage modules are available from ABB, or they can be fabricated by the switchgear assembler using standard ABB compartment drawings for reference.

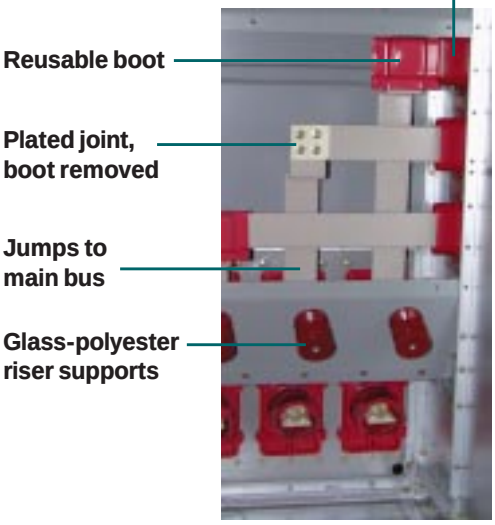
38-inch instrument compartment with TOC switch and terminal blocks for customer wiring and interframe connections.

Primary Bus System

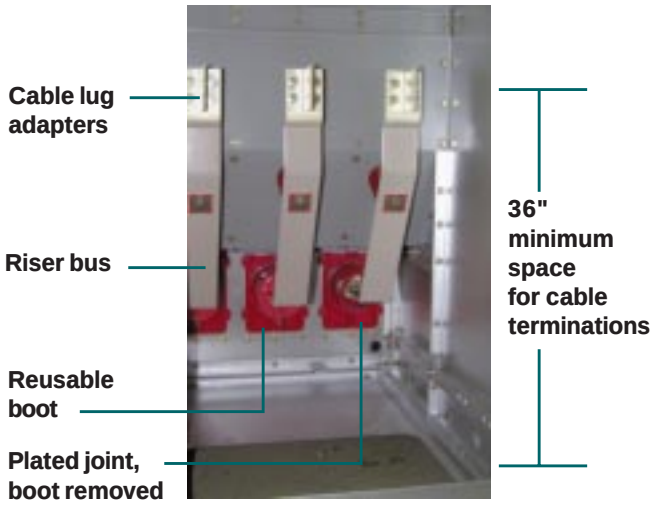
ADVAC circuit breaker modules and associated metal-clad components are fully tested in complete switchgear in accordance with rigorous ANSI requirements. The primary bus system used in the certified design consists of a 100% copper main bus in 1200, 2000 and 3000 A ratings. The main bus is epoxy-insulated with an advanced powder coat system. The bus is silver-plated at joints and bolted together with a minimum of two 1/2-inch SAE grade 5 bolts. Removeable, reusable boots are provided for each joint. The main bus is not tapered and is easily extended at both ends.

The main bus and all jumps (connections from stationary primary contacts to the horizontal bus) and risers (connections from stationary primary contacts to line or load terminations) are rigidly supported by insulating standoffs. Standard internal standoffs are Class A20 glass-polyester. Standard interframe supports are also glass-polyester. Porcelain insulator options are available.

Main bus sizes are identified in the Reference Section.



Main Bus Compartment
(End section—cover removed)



Cable Compartment
(Main bus cover installed)

Accessories

The ADVAC accessory group includes a complete array of required and optional special tools for proper handling, operation and maintenance of the circuit breakers and compartments.
For maximum convenience, all withdrawable assemblies - circuit breakers, PTs, CPTs, and fuses - use the same accessories.

Required accessories include a handle for manually charging the circuit breaker operating mechanism, and a racking crank for inserting and removing primary assemblies. A standard 16 mm socket wrench with a swivel adapter can be conveniently used for racking.

A lift truck is also required for circuit breakers and other drawout primary devices. The lift truck is a foot-operated hydraulic device that docks with the switchgear, allowing a primary device to be raised or lowered to the appropriate height and safely rolled into the compartment. The lift truck has wheels for easy maneuvering in restricted aisle space common to switchgear installations.

Primary devices are secured to the lift truck in the same manner used for locking the devices into switchgear compartments. The lift truck platform is lowered to a safe position before it is used as a temporary transport device. All primary devices have self-contained wheels for easy rolling on the floor and onto the lift truck.

A “test jumper” is an extension cord that allows the secondary disconnect on a circuit breaker outside a breaker compartment to be connected to the female connector inside the compartment. This enables the breaker to be electrically operated using controls in the switchgear, or electrically charged after manual operation of the breaker in a switchgear aisle.

An optional lifting yoke is a simple hook, chain and spreader bar assembly used to lift circuit breakers with an overhead crane or hoist.

A “test cabinet” is a wall-mounted control cabinet connected to a separate power source and containing switches to open and close a breaker. The test cabinet has a female connector and an umbilical cord (stored inside the cabinet) for connection to the breaker, and serves as an aid to breaker inspection and maintenance in switchgear aisles or work areas.

Ground and Test Devices

A “G&T device” is a drawout assembly compatible with circuit breaker compartments. The G&T provides a means to select and test primary circuits in a controlled manner, and then to connect deenergized primary circuits to the switchgear ground bus to support maintenance activity. Refer to drawing on page 52 in the Reference Section.

The racking system of the grounded G&T device can then be padlocked or Kirk Key interlocked in the Connected position in accordance with lock-out and tag-out safety procedures.

Dummy Circuit Breakers

A "Dummy Breaker" is a no-load disconnect device similar to a drawout circuit breaker, but without an operating mechanism, controls or interrupters. It provides a three-phase short circuit current path between upper and lower terminals, and usually serves to isolate entire switchgear line-ups or specific loads for maintenance work. Dummy devices do not have load interrupting capability, and must be Kirk Key interlocked with the switchgear power source to prevent racking when primary circuits are energized.

TECHNICAL SPECIFICATIONS

ADVAC
Advanced Design Vacuum Circuit Breaker

ADVAC - Advanced Design Vacuum Circuit Breakers

Technical Specifications

This section describes the basic design and functional requirements for vacuum circuit breakers and indoor (NEMA 1) metal-clad switchgear components. It is provided as a guide to assist in the specification of switchgear, circuit breakers and related components to assure superior safety, reliability and maintainability in the final switchgear product. Features and provisions identified as optional should be selected as appropriate for the application. This guide does not provide comprehensive recommendations for overall switchgear design, protective relaying, coordination or instrumentation. This guide also does not address requirements for outdoor applications.

Tables are located in the Reference Section.

This document is available in electronic format for word processing use from the ABB web-site (http://www.abb.com/usa/t&d) or from an ABB OEM field sales representative. For additional information, contact a sales representative or the ABB North America Distribution Switchgear Group at 1-800-338-1585.

Introduction

This specification covers the general requirements for medium voltage metal-clad switchgear. Specific application requirements are identified on project data sheets and single-line diagram(s). In general, when resolving conflicting information, the following order of precedence shall apply:

1. Single-line diagrams
2. Data sheets
3. This specification
4. Purchase order
5. Other referenced specifications

General Description

The metal-clad switchgear shall be of free standing, self-supporting modular construction in one-high and two-high arrangements. The standard indoor frame size shall consist of 36-inch wide sections with modules stacked to a height of 95 inches (maximum). A dress panel shall be provided on each end of a lineup. The lineup may be extended on either end (unless coupled to other equipment) by removal of the end dress panels and the main bus covers.

The switchgear shall be provided with ABB ADVAC vacuum type drawout circuit breakers or approved equal. The switchgear shall include circuit breaker and auxiliary compartments, drawout breakers and auxiliary assemblies, the primary bus system, ground bus system, protection and control devices, and connection provisions for primary, ground and control circuits, all functionally equivalent to project single-line diagrams and data sheets except as noted.

Applicable Standards

The switchgear and circuit breakers shall be designed, tested and manufactured in accordance with ANSI requirements for metal-clad switchgear and the following applicable documents and industry standards:

ANSI/IEEE	C37.04	Standard Rating Structure for AC HV Circuit Breakers
	C37.06	Preferred Ratings for AC HV Circuit Breakers
	C37.09	Standard Test Procedure for AC HV Circuit Breakers
	C37.010	Application Guideline for AC HV Circuit Breakers
	C37.011	Application Guide for TRV for AC HV Circuit Breakers
	C37.012	Application Guide for Capacitance Switching
	C37.11	Requirements for Electrical Control
	C37.20.2	Standard for Metal-clad and Station-Type Cubicle Switchgear
	C37.55	Conformance Testing Procedure for Metal-clad Switchgear
	C57.13	Requirements for Instrument Transformers
NEC	National Electric Code, 1996 Edition	
NEMA	CC-1	Electrical Power Connections
	SG-4	Standards for Power Circuit Breakers
	SG-5	Power Switchgear Assemblies for NEC/NFPA
	250	Enclosures for Electrical Equipment

Ratings

The switchgear shall be rated at (4.76, 8.25, 15) kV maximum continuous voltage, (250, 350, 500, 750, 1000) MVA nominal interrupting capacity, and (1200, 2000, 3000) amps continuous current, as shown in the "Rating Structure" table (page 40), with required and related capabilities in accordance with referenced ANSI standards. Individual circuit breaker continuous current ratings shall be as shown on the project single-line diagram and data sheets.

Ratings are applicable to "General Purpose" circuit breakers as defined by ANSI, except where specific "Definite Purpose" breakers and ratings are noted in this specification or on project data sheets.

Switchgear will be designed for usual service conditions as defined in ANSI C37.20.2, and de-rating factors for unusual service conditions shall apply in accordance with this standard.

Materials and Construction

Circuit breaker and auxiliary compartments shall be of modular construction and fabricated primarily from 14-gauge pre-coated Galvalume material (zinc-aluminum over cold-rolled carbon steel). Galvalume shall not require painting due to superior corrosion resistance. Those components, doors and panels which require welding, or which require greater than 14-gauge material (and not accomplished by double walls of 14-gauge material), shall be of carbon steel that has been phosphate treated and painted with ANSI 61 (gray) baked-on corrosion resistant epoxy enamel.

Hem-bends (rigid overlap bending) shall be consistently used to enhance strength and to minimize potential exposures to sharp steel edges during installation and maintenance.

Exterior doors and panels shall be securely hinged and fastened, and shall be capable of handling the weight of door-mounted components without deformation or sagging.

Door stops shall be provided to hold doors in the full open position.

Options:

Primary compartment doors shall be provided with windows of polycarbonate material to allow viewing of primary device position and indicators mounted on the front of circuit breakers.

Provisions shall be made for the addition of Kirk Key Interlocks as indicated on project single-line diagrams and data sheets.

Circuit Breaker Compartments

Circuit breaker compartments shall be rated as shown on the project single-line diagram and data sheets, and shall include support bushings with stationary primary contacts for engagement with circuit breakers or ground and test (G&T) devices. Standard bushings shall be glass-reinforced polyester in 1200 A and 2000 A compartments, and porcelain bushings in 3000 A compartments. The bushings shall be capable of supporting the weight of specified current transformers. Primary contacts shall be made of copper and designed to accept round, tulip-style connectors.

Option: The 1200 A and 2000 A circuit breaker compartment bushings shall be porcelain.

Low voltage, ring-core type current transformers (CTs) shall be bushing-mounted, located behind the shutters and accessible from the front. Bushing design shall accommodate up to four standard accuracy CTs per phase for all ratings.

Solidly grounded metal shutters shall operate automatically by withdrawing or inserting the circuit breaker or G&T device. The shutters shall block access to primary contacts when the breaker is in the Test or Disconnected positions or withdrawn from the compartment. Shutter grounding shall be by dedicated ground wires, and shall not depend on grounding through hinges or moving contact surfaces. Shutters shall be driven from both sides simultaneously for smooth, balanced operation. Shutter closing shall be automatically driven by the breaker, and shall not depend on gravity or spring return systems. Shutters shall be lockable in the closed position (padlocks supplied by others).

Option: The shutters shall be made of non-metallic polycarbonate material.

A stationary ground contact shall be provided to interact with the ground contact of the circuit breaker. The ground connection shall be made prior to making of the primary or secondary contacts, and shall be continuous from Disconnected through Connected positions. Additionally, circuit breakers shall be grounded through the chassis and racking system in all positions.

A single (25-pin) fully automatic self-aligning secondary disconnect shall be provided as standard. The female portion of the disconnect system shall reside in the breaker compartment, so that energized contacts are recessed and remain “touch safe.”

Option: A double (50-pin) disconnect arrangement shall be provided for compatibility with appropriately equipped circuit breakers, as shown on project data sheets.

Circuit breaker compartments shall have interference blocking to prevent the insertion of improperly rated devices. Breakers and G&T devices rated at 2000 A shall be physically interchangeable in 1200 A compartments for economy of spare devices. Note: Circuit breakers having dual secondary disconnects are not interchangeable with devices using a single secondary disconnect.

Refer to "Vacuum Circuit Breakers" for additional information on circuit breakers.

Auxiliary Compartments

Auxiliary compartments shall be provided where necessary for mounting one or more of the following drawout auxiliary units, as shown on project single-line diagrams and data sheets:

- Drawout potential transformers (PTs) with disconnecting type primary current limiting fuses, with one or two drawers optional in a vertical section with one circuit breaker or fuse/CPT compartment. Each drawer shall contain up to 3 PTs, connected L-L or L-G.
- Drawout control power transformers (CPTs) with disconnecting type primary current limiting fuses, with one drawer optional in a vertical section with one circuit breaker compartment, or up to two drawers in a vertical section with no circuit breaker compartment. Each drawer shall contain one CPT, up to 15 kVA single phase, connected L-L or L-G. Secondary breakers shall be provided on ungrounded secondary legs.
- Drawout current limiting fuses for stationary CPTs, with one drawer optional in a vertical section with one circuit breaker compartment, or up to two drawers in a vertical section with no circuit breaker compartment. Each drawer shall contain up to three fuses connected L-L or L-G.

Drawout CPTs and fuse units for stationary CPTs shall be provided with an interlock to a switch or secondary circuit breaker to prevent withdrawal of an energized unit.

Drawout units shall use the same racking system as the circuit breakers for open or closed door racking (except that no Test position applies), and shall use the same accessories as the circuit breakers. Primary connections shall be made by tapered, self-aligning silver-plated copper contacts mounted on glass polyester bushings and connected to primary circuits by rigid conductors or properly braced cables. The primary contacts shall be of a recessed arc-quenching design that interrupts magnetizing current and prevents incidental contact with energized circuits.

Secondary PT and CPT connections shall also be self-aligning copper contacts. Primary and secondary connections shall be fully automatic during insertion and withdrawal of the auxiliary unit.

Option:

Porcelain bushings shall be supplied as supports for stationary primary contacts in auxiliary compartments.

Drawout auxiliary trucks shall be grounded at all times. Transformer windings or primary fuses shall be grounded when withdrawn to discharge residual current.

Bus and Cable Compartments

The primary bus system shall be made of 100% copper with full round edges, and shall have self-cooled ratings as specified on the project single-line diagram or data sheets. Bus bar connections shall be silver-plated and mechanically secured with reusable hardware that will maintain adequate pressures with the operating temperature range of the switchgear.

Conductors shall be epoxy insulated, except at bolted joints. Joints shall be covered with removable, reusable boots to facilitate field inspection and maintenance.

The main (horizontal) bus compartment shall be separated from the other compartments by an 11-gauge steel barrier (or equivalent) and shall fully enclose the main bus. The main bus compartment shall be accessible from the rear through the cable compartment. Main bus ratings shall match the highest rated circuit breaker continuous current ratings (unless a higher rating is specified on the project single-line diagram or data sheets) and shall comply with ANSI temperature rise requirements. The main bus shall not be tapered.

Bus supports and insulation materials shall be flame-retardant, track resistant, and non-hygroscopic. Supports for 1200 A and 2000 A units shall be glass-reinforced polyester. Supports for 3000 A bus shall be porcelain.

Option:

Bus supports for 1200 A and 2000 A shall be porcelain.

A termination bus shall be provided from the circuit breaker primary disconnects to a location to allow cable connections to other equipment. Bus connections to cables and bus duct shall be rigid. Termination bus arrangements shall allow at least 36 inches for primary cable terminations and stress cones. Connections to roof entrance bushings shall be of the flexible type. Standard termination bus shall meet the bolt hole requirements of NEMA CC-1-4.05, and will typically be the NEMA four-hole pattern.

Option:

Crimp or compression type cable lugs will be provided for each switchgear section as shown on project data sheets.

The design shall be adaptable for top or bottom primary entrance arrangements. In two-high arrangements, each set of primary connections and zero-sequence current transformers, if applicable, shall be isolated into separate compartments by a grounded steel partition in accordance with ANSI standards. Easily removable primary and secondary cable entry plates of carbon steel shall be provided.

Options:

Cable entry plates shall be of non-magnetic material.

The cable compartment shall have mounting provisions for surge arresters, ground sensors and cable supports as shown on project data sheets.

A 1/4 x 2 inch solid copper ground bus, to which the entire metallic enclosure is solidly connected, shall extend through the length of the switchgear. The ground bus shall be accessible in the cable compartment, and shall have connection provisions for each switchgear section.

Vacuum Circuit Breakers

General

The circuit breaker shall be an ABB ADVAC or approved equal three-pole drawout type breaker, electrically operated, with manual or electric motor charging of a spring type stored energy operating mechanism. The breaker is intended for use as a General Purpose device in accordance with applicable ANSI standards.

Option:

Definite purpose or non-standard ratings are required in accordance with project data sheets, and availability is confirmed in writing with the vendor.

Circuit breakers of the same type, rating and control features shall be electrically and mechanically interchangeable.

Racking System and Interlocks

The circuit breaker shall be inserted and withdrawn by means of a racking system, which can be operated with the compartment door open or closed. The racking system shall provide smooth, consistent racking, and shall secure the breaker from both sides of the cell in all racking positions. During racking, the breaker shall automatically open and close cell-mounted safety shutters to cover stationary primary contacts when the breaker is not in the Connected position.

The racking system shall have three distinct positions, in addition to the withdrawn position (free movement): Disconnected (both primary and secondary contacts disengaged), Test (primary contacts disconnected and shutter closed, but control contacts engaged), and Connected (primary and secondary contacts engaged). Positive stops shall be provided for all three positions, with deliberate operator intervention required to enable continued insertion or withdrawal of the breaker from any position.

The racking system and all moving parts of the breaker-cell interface, including the secondary coupler, shutter actuator and ground contact, shall be capable of 250 complete rack-in/rack-out operations without maintenance.

It shall not be possible to insert or withdraw a closed breaker, and the breaker shall not be allowed to close within a cell unless it is in a positive Connected, Test, or Disconnected position. The springs in the stored-energy operating mechanism shall be automatically discharged prior to removing a circuit breaker from a compartment. (other than spring pre-load charges which do not have the capacity to operate the circuit breaker).

Controls

Opening and closing speed shall be independent of the operator or of control voltage within the rated control voltage range. Circuit breaker charge, close and trip circuits shall be electrically separate, and control voltages for each circuit shall be independently selectable from the full range of ANSI preferred control voltages. Manual provisions shall be provided for closing, tripping and charging the breaker. These provisions shall be installed and easily accessible at the front of the breaker.

A self-aligning, fully automatic secondary coupling system shall be used to connect and disconnect all control wiring during circuit breaker insertion and withdrawal. The secondary disconnect shall require no manual intervention to attain proper position when the breaker is racked to the Connected, Test or Disconnected positions. Secondary contacts shall use a tin-lead contact finish.

The breaker shall include eight on-board auxiliary contacts (4 “a”, 4 “b”) for customer use, wired through the secondary disconnect. All breaker-mounted contacts shall operate in both Connected and Test positions.

Option:

Nine additional contacts (5 “a”, 4 “b”) shall be installed on the breaker and wired through the secondary disconnect, for a total of 17 on-board contacts.

The breaker shall have flags to indicate open or closed position, and spring charge status. Only the correct status flag for any single function shall be visible. Pointer systems shall not be used to indicate status. Additionally, the breaker shall have a five-digit, non-resetting operation counter clearly visible from the front of the breaker. The operation counter shall advance when the breaker opens.

A solid state control device shall be used to assure proper sequencing of anti-pump circuits. Mechanical relays shall not be used.

All control devices shall be universal AC/DC, or DC supplied through rectifiers, for AC or DC application flexibility with standard parts. All control components shall be front-accessible for inspections and easily removable for maintenance.

Options:

Dual isolated direct-acting shunt trip coils shall be supplied for breakers as noted on data sheets, and wired through separate secondary control sources for complete redundancy.

A direct-acting undervoltage trip shall be supplied for breakers as noted on data sheets. The undervoltage trip shall operate when the control voltage drops to a predetermined value below the nominal control voltage.

Current Path

Each primary lead assembly shall consist of a vacuum interrupter housed in a glass-polyester support, with copper upper and lower leads, and shall use tulip-type self-aligning primary disconnects. Current transfer to moving interrupter stems shall be via flexible connectors or brush contacts with no moving parts. Primary disconnects and contact surfaces of other current carrying parts shall be silver-plated.

A dedicated ground contact shall be provided to engage the stationary ground contact in the circuit breaker compartment to ground the circuit breaker in all positions from Disconnected through Connected.

Maintenance and Handling

The operating mechanism shall be front-accessible, and all routine maintenance shall be performed with the breaker in an upright position. Interrupters shall have a contact wear indicator or other simple contact measurement that requires no special tools. Circuit breakers shall have self-contained wheels designed for easy insertion, removal and transport on flat indoor surfaces.

Protection and Control

Relays and Instruments

Relays and instruments shall be provided and wired as specified on the project single-line diagram and data sheets. Multi-function, three-phase microprocessor-based relay and control devices shall be used to the maximum practical extent. For maximum safety and ease of maintenance, the use of larger low voltage compartments and one-high construction shall be given precedence over stacked primary compartments when alternative relay and instrument types are used. Door-mounted protective relays shall be drawout type whenever practical.

Electromechanical meters, when used, shall be the flush-mount 1% accuracy taut-band switchboard type, with a minimum 250% scale.

Current Transformers

ABB type SAB current transformers shall be supplied as shown on project data sheets and the single-line diagram. Zero sequence transformers shall be ABB type BYZ-S. Ratings and accuracy class shall be in accordance with ANSI C57.13. CT nameplates shall be located on the CT housing and information provided shall be in accordance with ANSI C57.13. CT windings shall terminate on screw type terminals on the CT housings and shall be wired to shorting terminal blocks.

Potential Transformers

ABB type VIY and VIZ potential transformers shall be supplied in accordance with project data sheets and the single-line diagram. Potential transformer ratings and accuracy class shall be in accordance with ANSI C57.13 and designed to withstand the Basic Impulse Level (BIL) of the switchgear. Potential transformers shall always be fused. Potential transformers shall be mounted as draw-out devices in auxiliary compartments.

Auxiliary Switches

Circuit breaker auxiliary contacts shall be used instead of cell-mounted mechanism operated contacts (MOC switches) for each breaker so noted on project data sheets. The auxiliary contacts shall be wired through the automatic secondary disconnect system. Refer to “Vacuum Circuit Breakers” for additional requirements.

Option:

A four contact (2 “a”, 2 “b”), eight-contact (4 “a”, 4 “b”) or twelve-contact (6 “a”, 6 “b”) truck operated contact (TOC) actuator and switch assembly shall be provided to indicate when the breaker is in the fully Connected position, for each breaker so noted on project data sheets.

Spare contacts shall be wired to terminal blocks for easy access and future use.

Control Switches

Breaker control switches shall use pistol-grip handles and will not be mounted adjacent to meter switches. Meter switches shall use knurled-type round handles. Control and instrument switches shall be provided and wired in accordance with specified single-line diagrams and data
sheets, and shall be mounted only on low voltage compartment doors and panels.

Control Wiring

The switchgear shall use 14 AWG type SIS stranded extra-flexible, 600 volt flame retardant and UL-listed switchboard wire. Larger wire sizes up to #8 may be used as necessary for CT circuits. Control bus, where provided, shall be #8 AWG minimum, depending on required ampacity.

Terminal blocks for customer connections shall be provided in the low voltage compartment. Internal wiring shall be connected to only one side of these terminal blocks, with a maximum of two wires per terminal, and terminals shall be clearly marked.

Control wiring shall be enclosed in a grounded metal wireway when routed through a high voltage compartment. Splices are not permitted, except at terminal blocks. Wiring shall be neatly bundled and tied or secured in plastic wireways on doors and in low voltage compartments, and shall be protected from rubbing against door flanges or other parts of the enclosure.

Control circuits shall incorporate all necessary switching and protective devices, such as fuses or molded case circuit breakers, as specified on project data sheets. Charge, close and trip circuits shall be separately fused. Dead-front pull-fuse blocks shall be used for circuit protection and disconnect. Vendor's recommended fuse sizes for each control voltage shall be used. Ends shall terminate with ring-tongue terminals on screw-type terminal blocks, unless prohibited by the design of connection ponts on control devices. Terminal block screws shall use vibration-resistant hardware. Interframe connections shall be made only at low voltage compartments.

Options:

Sleeve-type wire markers shall be provided at both ends of each wire.

Ring-tongue terminals shall be insulated.

Space Heaters

Space heaters shall be provided at appropriate locations in each vertical section. Heaters shall be protected to prevent accidental contact by operating personnel.

Options:

Space heaters shall be separately fused for each vertical section or breaker, as applicable. Space heaters shall be energized whenever circuit breakers are open or controlled by an automatic thermostat located in each vertical section or lineup, as shown on project data sheets. Optional heater controls shall include disconnect switches, bypass switches, ammeters and thermostats.

Note: Space heaters shall be standard on outdoor equipment.

Accessories

The following accessories shall be provided for each lineup or in quantities as noted on project data sheets:

- Hand crank (16 mm socket drive) for manually operating racking system for the circuit breaker, PT, CPT, or draw-out fuse (required)
- Handle for manually charging the stored energy system on circuit breakers (required)
- Transport and lifting device to allow a circuit breaker, or auxiliary drawout unit, to be elevated and then inserted or withdrawn from upper or lower compartments (required)

Options:

- Electrical test jumper for connecting the breaker to the switchgear control circuit while the breaker is completely out of the cell
- Electrical test cabinet with door-mounted open and close pushbuttons for testing the circuit breaker away from the switchgear
- Ground & Test device – three-terminal or six-terminal, manually operated standard device
- Lifting yoke or similar breaker accessory for overhead lifting of circuit breakers

Documentation

Standard approval drawings shall consist of a system single-line drawing; general arrangement; front view; floor plan; nameplate drawing; and bill of materials. Final drawings shall consist of as-built approval drawings plus three-phase elementary, schematic, and interconnection wiring diagrams.

Drawings shall indicate all equipment, but only such equipment, as is actually in the switchgear scope of supply. All user connection and interface points shall be clearly marked, including primary and secondary cable entrances and connection points; installation details; and inter-frame assembly and connection details for shipping splits.

Drawings shall be professionally prepared on computer aided drafting systems to the maximum extent practical, and shall be provided to the customer by electromagnetic disk or on reproducible and paper copies in quantities as shown on project data sheets.

An instruction manual shall be provided with necessary information for receiving, handling, storage, installation, operation and maintenance. The instruction manual shall assist in identification and ordering of recommended spare parts.

Testing and Verification

Design tests, to verify ANSI ratings as identified in this specification, shall be documented as required by ISO 9001 and available for review and inspection.

REFERENCE

ADVAC
Advanced Design Vacuum Circuit Breaker

ADVAC - Advanced Design Vacuum Circuit Breakers

Reference

Rating Structure

The following table identifies standard ADVAC circuit breaker types and ratings, and provides the most commonly required ratings and related capabilities for metal-clad switchgear. ADVAC circuit breakers are suitable for "General Purpose" applications as defined by applicable ANSI standards (refer to Technical Specification). Contact the factory for availability of non-standard or "Definite Purpose" ratings.

Breaker Type	Nominal Voltage Class kV	Nominal MVA Class	Rated Voltage kV		Low Freq. Withstand Voltage kV rms	Impulse Level (BIL) kV Crest	Rated Short Circuit Current kA Sym		Capability		Rated Voltage Range Factor
			Min. rms	Max. rms			@ Min. kV	@ Max. kV	Short Time kA rms 2 Sec.	Close and Latch kA_{Peak}	
5ADV36	4.16	250	3.8	4.76	19	60	36	29	36	97	1.24
5ADV49	4.16	350	4	4.76	19	60	49	41	49	132	1.19
7.5ADV41	7.2	500	6.6	8.25	36	95	41	33	41	111	1.25
15ADV23	13.8	500	11.5	15	36	95	23	18	23	62	1.3
15ADV36	13.8	750	11.5	15	36	95	36	28	36	97	1.3
15ADV48	13.8	1000	11.5	15	36	95	48	37	48	130	1.3

NOTES:

1. Each circuit breaker is available in continuous current ratings of 1200, 2000 or 3000 A rms.
2. Interrupting time is rated at 5 cycles (0 — 100%).
3. The asymmetric capability ratio rating is 1.2.
4. Ratings are 50/60 Hz basis.

Capacitance Switching Ratings

Capacitance switching ratings are as specified in the table below and are subject to the following conditions.

1. The transient voltage from line-to-ground shall not exceed three times the maximum design line to ground crest voltage as measured at the circuit breaker terminals.
2. The number of re-strikes or re-ignitions shall not be limited as long as the transient voltage to ground does not exceed the value given in number 1 above.
3. The capacitor rating applies only to "Single Bank Switching".

Interrupting time is in accordance with the rated interrupting time of the circuit breaker.

Rated Maximum Voltage (kV RMS)	Rated Short Circuit Current (kA RMS)	ADVAC Breaker Continuous Current Rating			
		1200 A		2000 A	
		General Purpose	Definite Purpose	General Purpose	Definite Purpose
4.76	29	400	630	400	1000
4.76	41	400	630	400	630
8.25	33	250	630	250	1000
15.0	18	250	630	250	1000
15.0	28	250	630	250	1000
15.0	37	250	630	250	630

Contact factory for availability of capacitance switching information on 3000 A circuit breakers.

Altitude Rating Correction Factors

This table must be used in accordance with ANSI C37.04 to correct published circuit breaker ratings for operation at altitudes over 3,300 feet above sea level.

Altitude (ft.)	Rating Correction Factor*	
	Continuous Current	Voltage & Dielectric Withstand
3,300 (and below)	1.00	1.00
5,000	0.99	0.95
10,000	0.95	0.80

*Values for intermediate altitudes may be derived from linear interpolation.

Mechanical Endurance

ADVAC circuit breakers are subjected to extensive testing for durability in accordance with ANSI standards. This information is provided as a guide to maintenance planning under normal operating conditions. Actual experience may vary based on operational conditions and maintenance practices. Tested values of accumulated interrupting duty (KSI) do not constitute warranted performance.

Breaker Types	5ADV36 7.5ADV41 15ADV36	15ADV23 (see 15ADV36 for 2000 A rating)	5ADV49 15ADV48	All
Continuous Current	**1200-2000 A**	**1200 A**	**1200 - 2000 A**	**3000 A**
No-load mechanical	10,000	10,000	5,000	5,000
Between servicing	2,000	2,000	1,000	1,000
Full load current	1,000	1,000	500	500
Rated KSI	800%	800%	800%	800%
Tested KSI	2300%	1425%	815%	815%

Noise Level

Noise level measurements of circuit breaker operations with compartment door open or circuit breaker withdrawn from cell.

Open, peak (dBA) at 3 ft	< 105
Close, peak (dBA) at 3 ft	< 105

Auxiliary and TOC Switches

Circuit breaker auxiliary switches operate whenever the breaker opens or closes. Contacts are compression type, mounted on the breaker and wired to switchgear terminal blocks through the secondary disconnect system. Contacts are operated through simple mechanical links from an auxiliary drive shaft which rotates in conjunction with the main drive shaft. Switch contacts are silver-plated.

The standard contact configuration is four "a" contacts (normally open when the breaker is open), and four "b" contacts (normally closed when the breaker is open). An optional dual secondary disconnect enables the addition of five "a" contacts and four "b" contacts, for a total of nine "a" and eight "b" contacts. The contacts are not field reversible.

Auxiliary contacts operate whenever the breaker is operated, regardless of breaker position in the compartment. If control circuits require differentiation between connected and disconnected positions, it is necessary to wire an optional truck operated contact (TOC) into the appropriate auxiliary switch circuit(s).

Auxiliary Contact Current Ratings	Continuous (A)	Switching (A)
@ 250 VDC	10	2.0
@ 125 VDC	10	4.0
@ 48 VDC	10	6.0
@ 24 VDC	10	7.7
@ 240 VAC	10	10.0
@ 120 VAC	10	10.0

TOC Switch Current Ratings	Continuous (A)	Switching (A)
@ 250 VDC	20	5.0
@ 125 VDC	20	10.0
@ 48 VDC	20	12.0
@ 24 VDC	20	15.0
@ 240 VAC	20	10.0
@ 120 VAC	20	15.0

Optional TOC switches are actuated by movement of the ADVAC front panel to indicate when the breaker is in the Connected position. TOC switch contacts are mounted in an isolated low voltage area at the top of the breaker compartment. TOC switches are available with four, eight or twelve contacts, with an even number of "a" contacts (normally open when breaker is not Connected) and "b" contacts (normally closed with breaker is not Connected). Contacts are not field-reversible.

Close and Trip Coils

Circuit breaker close and trip coils are reliable solenoids with rotary movement that actuate appropriate operating mechanism linkages.

All coils operate from DC voltages supplied by a solid state control device (SSCD). The SSCD contains rectifiers that adapt the coils to AC or DC supply voltages, and uses solid state components to replace conventional anti-pump closing circuits. Conventional wire-wound resistors for AC controls are also eliminated. The SSCD module uses a highly reliable locking connector, and is easily replaceable for convenient control voltage changes.

Nominal Coil Voltage (V)	Trip Coil		Close Coil		Impedance +/- 5% (Ohms)	Recommended Class RK-5 Fuse Size (A)
	Rated voltage range (V)	Nominal Current (A)	Rated voltage range (V)	Nominal Current (A)		
24 VDC	20-28	9.6	—	—	*	15
48 VDC	28-56	4.8	38-56	4.8	47	15
125 VDC	70-140	3.0	100-140	3.0	198	15
250 VDC	140-280	1.5	200-280	1.5	8	15
120 VAC	104-127	3.0	104-127	3.0	198	15
240 VAC	208-254	1.5	208-254	1.5	8	15

*Contact factory for impedance value

Note that the minimum value for the 24 VDC trip coil is higher (more restrictive) than the normal range defined by ANSI standards.

24 and 48 VDC control functions are not recommended unless near the battery source, or unless special effort is made to ensure adequacy of conductors.

AC trip voltages are not recommended under any conditions, due to the reliability of AC power sources. If the only available control power source is AC, the recommended procedure is to use a capacitor trip device for each trip circuit.

ADVAC circuit breakers are available with a second trip coil. This option uses the standard trip coil, except that a different control voltage may be selected. A dual secondary disconnect must be used whenever a second shunt trip is specified. This provides complete redundancy of the trip circuit, from the trip coil through the secondary disconnect system to the switchgear terminal blocks.

ADVAC circuit breakers are also available with an optional undervoltage trip feature. This is a direct acting trip coil that actuates the trip linkage when the control voltage drops below 35 - 70% of the nominal range. This prevents a condition from happening in which control voltage is no longer available to trip a breaker. This feature is not available for 24 VDC trip circuits.

Charging Motor

ADVAC circuit breakers use a reliable and durable motor for electrically charging the toroidal spring in the stored energy operating mechanism. The two-pole universal motor is suitable for AC or DC voltages at each nominal rating. The motor is rated at 0.35 horsepower, and uses a 100:1 internal gear reduction. Advantages of this motor include a ventilated, lightweight aluminum housing; permanent internal lubrication; and a continuous duty rating.

Charge Motor	Nominal voltage range (V)	Nominal Current (A)	Inrush Current	Stalled Current (A)	No Load Current (A)	Charging Time (Nominal)	Recommended Class RK-5 Fuse Size (A)
48 VDC	38-56	8	6-8x	25.0	3.5	7-8 seconds	15
125 VDC	100-140	4		12.5	1.5		
250 VDC	200-280	2		6.5	0.8		
120 VAC	104-127	4		12.5	1.5		
240 VAC	208-254	2		6.5	0.8		

Electric charging requires 7-8 seconds at nominal control voltage.

The 48 VDC motor voltage is not recommended unless located near a battery or special effort is made to assure adequacy of conductors.

Manual charging is also quick and convenient, requiring approximately 25 easy strokes of a manual charging handle inserted at the front panel of the circuit breaker. The manual procedure takes about 25 seconds to complete.

Timing Characteristics

The ADVAC circuit breaker uses the same stored energy mechanism for all ratings, resulting in consistent operation and timing characteristics in all ratings and configurations.

Nominal closing time	60 ms
Nominal opening time	35-40 ms
Arcing time	< 15 ms
Nominal interrupting time	< 55 ms
Motor charging time	7-8 seconds *
Manual charging time	~ 25 seconds **

*at nominal control voltage
**requires approximately 25 strokes of charging handle

Vacuum Interrupters

ADVAC circuit breakers use superior quality vacuum interrupters with proven reliability over a long life. All interrupters use advanced copper-chrome contact material for superior performance and minimum current chop.

Breaker Types	5ADV36 7.5ADV41 15ADV36	15ADV23 (see 15ADV36 for 2000 A rating)	5ADV49 15ADV48	All
Continuous Current	**1200-2000 A**	**1200 A**	**1200 - 2000 A**	**3000 A**
Contact shape	Spiral			
Contact resistance (@ rated current)	<10 μΩ	<18 μΩ	<10 μΩ	<10 μΩ
Field design	Radial			
No-load mechanical life	10,000 operations		5,000 operations	
Vacuum (Torr)	10^{-8} to 10^{-7}			
Maximum chop current*	~5 A			
Moving stem current transfer method	Flexible	Flexible	Brush	Brush

***** Overvoltages are dependent on the surge impedance of the circuit

Main Bus Sizes

ADVAC design certifications are based on 100% copper bus with full round edges and sizes as shown in the following table. The main horizontal bus is not tapered. Connection joints are silver-plated, and at least two properly-torqued 1/2-inch SAE grade 5 steel bolts are used at each joint. The bus is epoxy insulated, and removable boots are used at joints.

Main Bus Sizes

	Rating	Quantity	Size
1200 A	5 kV, 250 MVA 15 kV, 500 MVA 15 kV, 750 MVA	1	.25" x 4"
1200 A	5 kV, 350 MVA 7.5 kV, 500 MVA 15 kV, 1000 MVA	1	.75" x 4"
2000 A	All	1	.75" x 4"
3000 A	All	2	.75" x 4"

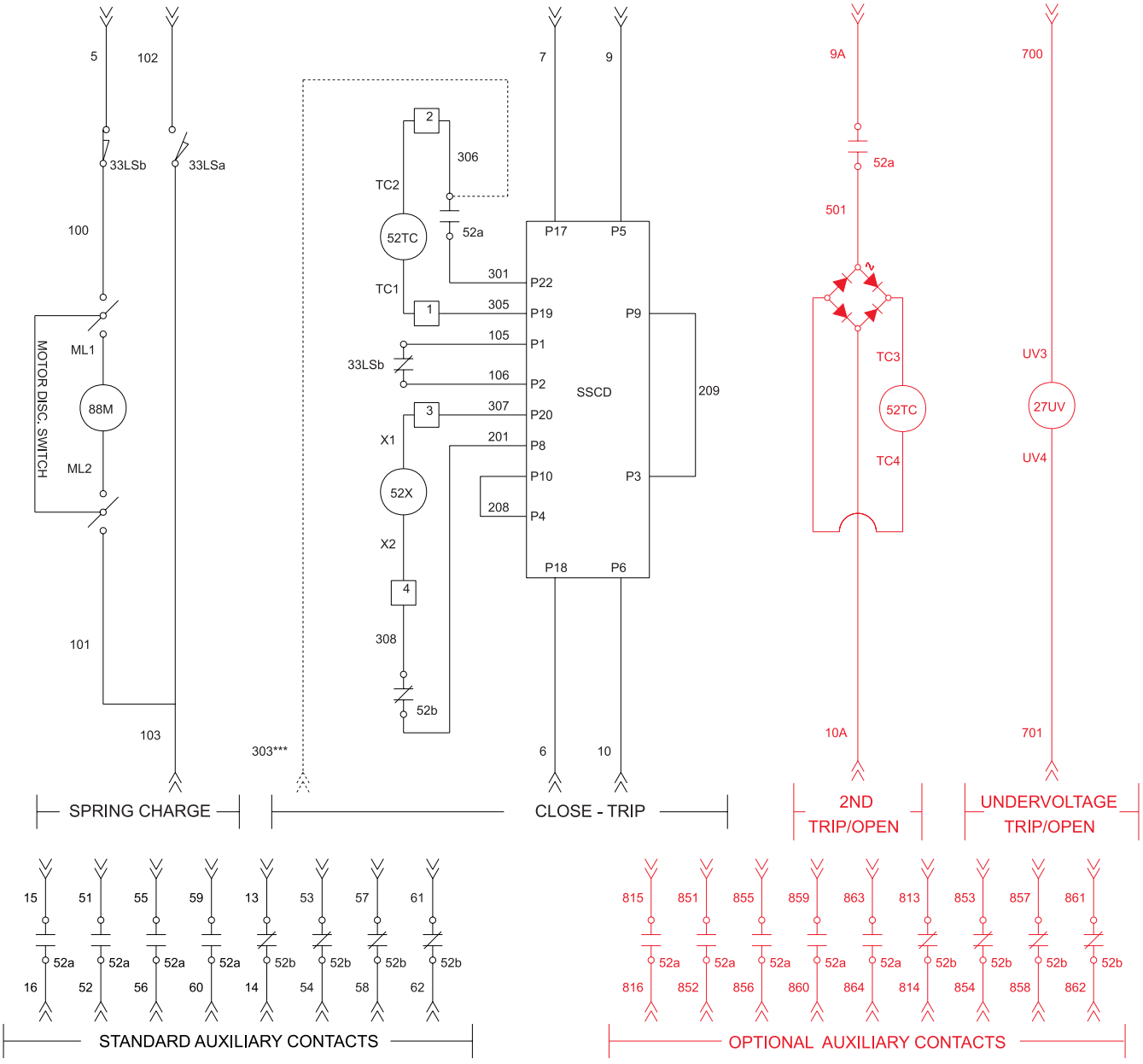
Bus Support Materials

ADVAC design certifications are based on glass-polyester and porcelain primary bus supports. Glass-polyester is standard for primary contacts and bus rated at 1200 A and 2000 A, and porcelain is standard at the 3000 A rating. Porcelain supports are also available at 1200 A and 2000 A. Separate drawings are available to indicate the position and dimensions of the compartment-mounted primary contact supports, inter-frame horizontal bus supports, and Class A-20 standoff insulators. Physical characteristics of glass-polyester and porcelain are provided in the following table.

Characteristic	Glass Polyester	Porcelain
Flexural Strength, psi	15 - 27,000	10,500
Tensile Strength, psi	14,000	6,000
Izod Impact ft-lb. per inch of notch	6 - 12	1.5
Thermal Shock cycles 32° - 2300°F	100+	1
Dielectric Strength (Short Time) vpm .125" thick, 25°C	350 - 375	300
Dielectric Constant	4 - 6	6

Circuit Breaker Schematic Diagram

ADVAC circuit breakers are available with two schematic diagrams. The basic schematic diagram is supplied with a single secondary disconnect. Additional auxiliary contacts, a second shunt trip device, and an undervoltage trip device are options that are available with the dual secondary disconnect.

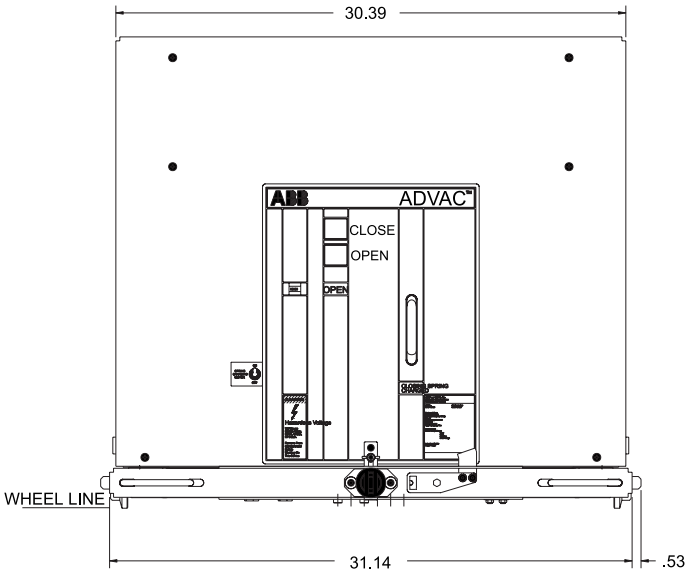


LEGEND

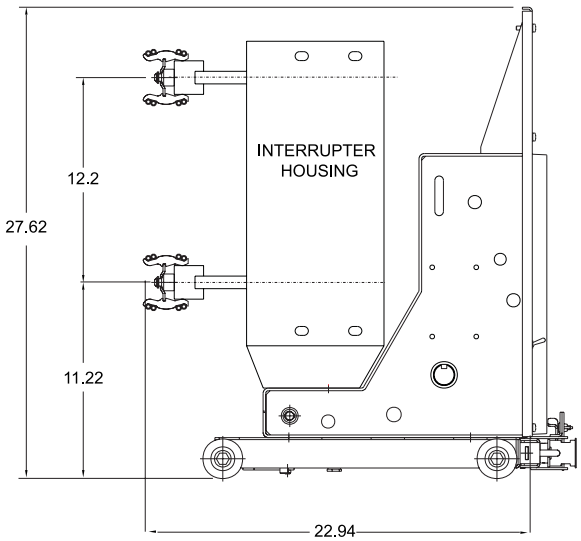
33 LS	Spring Charged Limit Switch	**88 M**	Spring Charging Motor
27 UV	Undervoltage Release	**SSCD**	Solid State Control Device
52 TC	Trip Coil	**303*** **	Trip Coil Monitor Wire for optional use
52 X	Close Coil		Note: Care must be taken to avoid full voltage/current to trip coil longer than pulse duration. Contact factory to order.
52 a,b	Auxiliary Contacts (shown breaker open)		

Circuit Breaker Outline

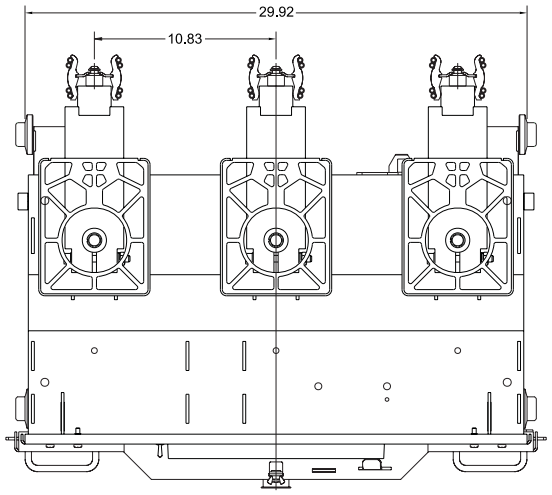
ADVAC circuit breaker dimensions are similar for all 36-inch wide compartments and ratings. The operating mechanism, control components, racking system and accessories are the same for all ratings. Breakers with higher interrupting and continuous current ratings use various primary lead assemblies and interrupter housings with different appearances, but cell interface dimensions are identical. To reduce racking force requirements, some 3000 A primary contacts are offset slightly to the rear for sequenced contact engagement.



Front View



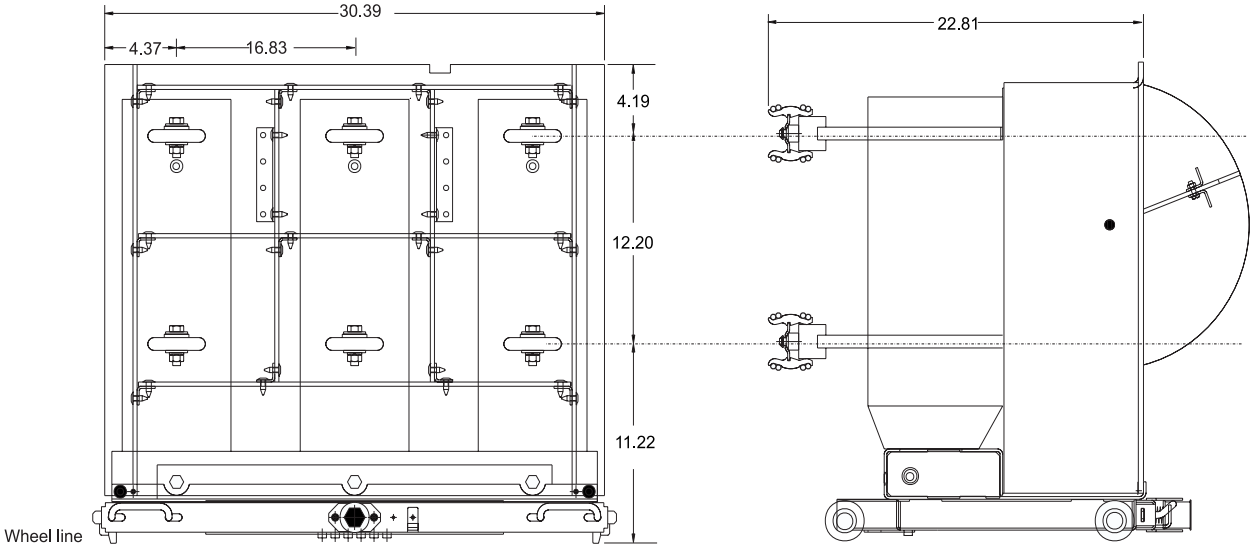
Side View



Top View

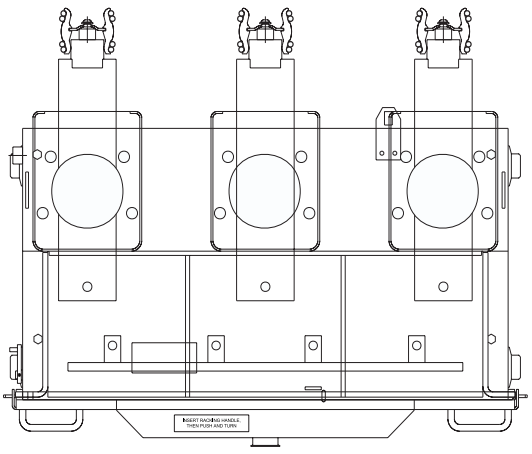
Ground and Test Device Outline

G&T devices are interchangeable with ADVAC circuit breakers in appropriately rated compartments. These devices provide a manual means to select and test primary circuits in a controlled manner, and then ground a set of de-energized primary contacts to the switchgear ground bus. The racking system can be padlocked to keep the G&T in the grounded position during maintenance activity. G&T devices are available with six terminals (shown below) or three terminals. Three-terminal devices can be ordered with upper or lower terminals. G&T devices are not rated for switching or interrupting duty. A single device can be used for both 1200 A and 2000 A compartments, and a separate G&T is required for 3000 A compartments.



Front View

Side View



Top View

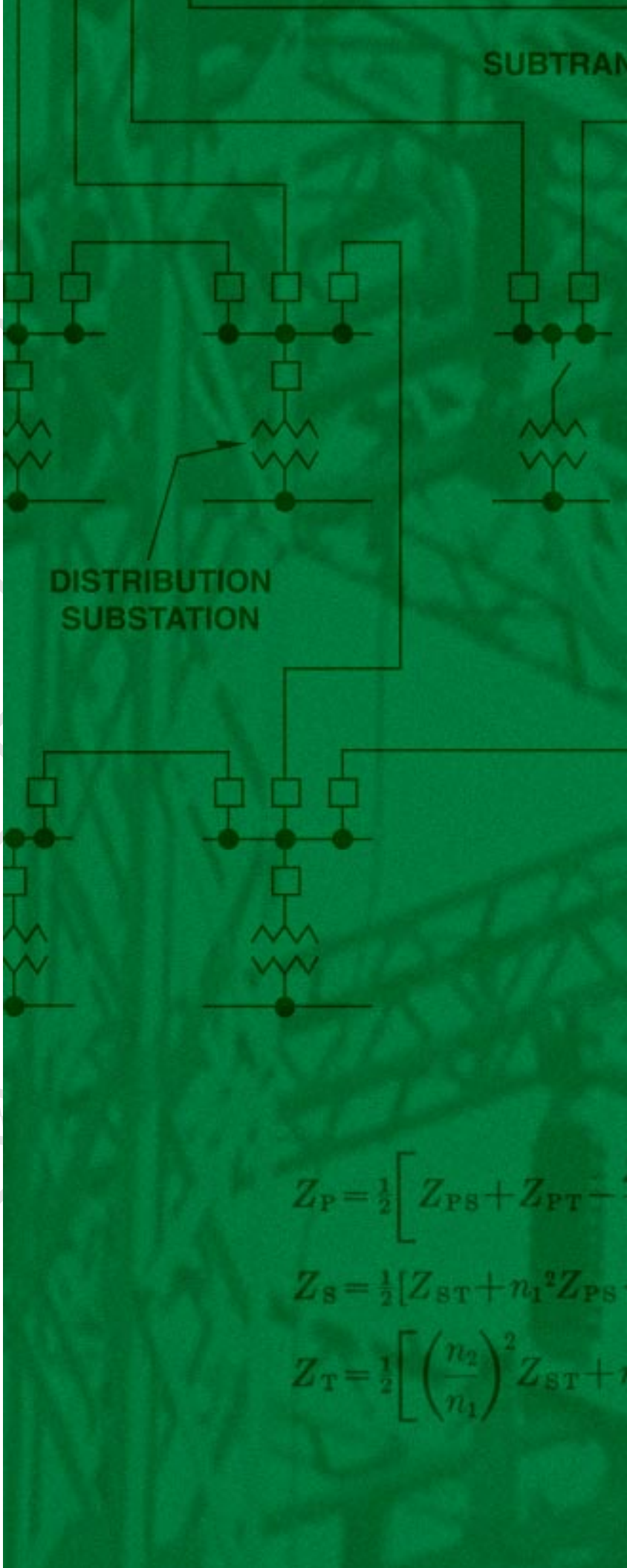
NOTES:

1. The device is for use with cells designed for ADVAC breakers.
2. Two (2) sets of cables are furnished. The short set attaches to the lower terminal set, and the long set attaches to the upper terminal set.
3. This device is designed for use with only one set of cables attached to a terminal set at any given time. Either the upper terminals are grounded through their cable set, or the lower terminals are grounded through their cable set.
4. Position stops are provided in the Connected and Disconnected positions. To assure that the device is in the fully Connnected position, the "Connect" label must be in the correct position.
5. Device cannot be stored in breaker compartments.

Typical Operating Procedure for Grounding the Circuit

1. Disconnect the ground cables from all terminals.
2. Swing the door over the device terminal set that is not be grounded.
3. Padlock the door in position.
4. Install the device in the switchgear compartment.
5. Close and secure the switchgear door.
6. Rack the device to the Connected position. The device must be in the fully Connected position. The Connected label must be in the appropriate position to assure that the device is installed properly.
7. Open the switchgear door.
8. Test the exposed terminal ends to assure that the terminal set to be grounded is not energized.
9. After establishing that the exposed terminal set is de-energized, close the switchgear door, and rack the device to the Disconnected position.
10. Open the switchgear door, with the device in the Disconnected position, and attach the upper or lower ground cables to the exposed terminal set.
11. With the grounded cables attached, close and secure the switchgear door and rack the device to the Connected position.
12. With the ground cables installed and the device racked to the Connected position, the terminal set connected to the ground cables is grounded to the switchgear ground bus.

NOTES



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