Descriptive Bulletin

R-MAG® magnetically actuated dead tank outdoor vacuum circuit breaker
15.5 kV - 38 kV
Introduction

The R-MAG® is truly the next generation in medium voltage vacuum circuit breaker technology. ABB is the first to combine the unique benefits of vacuum interrupter technology with a magnetic actuator designed to exploit these capabilities. Using a flux-shifting device with integral permanent magnets, the R-MAG mechanism has only one moving part. With simple open and close coils, an electronic controller and capacitors for energy storage, the R-MAG circuit breaker mechanism is capable of 10,000 load operations. These are a few of the features that mark a departure from the conventional spring-operated mechanism, introducing new capabilities and benefits for a smarter distribution system.

ABB makes safety our first priority by employing magnetic actuators to eliminate maintenance on coils, motors, and mechanically charged springs.

R-MAG benefits include:
- Simple, less frequent maintenance
  - Rated for 10,000 full load operations (five times ANSI requirements)
  - No maintenance required on magnetic actuator
  - Plug & play actuator circuitry
  - Vacuum interrupters rated for 30,000 full load operations
- Increased reliability
  - Magnetic actuator has only one moving part
  - No spring charging motors to replace
  - No trip/close coils to replace
  - Less moving parts leads to less maintenance

R-MAG increased performance
- 2,000 operations between servicing vs 500 operations between servicing - ANSI C37.06 requirements
- 10,000 mechanical or load operations vs 2,000 no-load mechanical operations - ANSI C37.06 requirements
- No maintenance required on magnetic actuator
- Eliminates open/close coils in stored spring mechanism lubrication requirements

The R-MAG has three main components:
- Vacuum interrupter assembly
- Operating mechanism
  - Provides reliable operation even after extended periods of inactivity
- Electronic control board
  - Compatible with all forms of overcurrent, reclosing and control functions
Manufacturing vacuum interrupters since 1980, ABB has become a worldwide leader in vacuum interrupter technology.

- Rated for 30,000 mechanical or load operations
- Up to 40 operations at maximum interrupting rating
- One of the largest vacuum interrupter producers in the world
- Environmentally friendly and maintenance-free for life
- ABB vacuum interrupters are used in many products globally
Magnetic actuator

ABB has utilized magnetic actuators since 1997. One global team is dedicated to designing magnetic actuators for ABB products, including R-MAG breakers.

- 15 kV rated at 100,000 mechanical operations
- 38 kV rated at 50,000 mechanical operations
- One moving part
- No maintenance required

Magnet life expectancy
Developments in magnetic material technology allow the magnetic actuator to be highly reliable over a long life time. Reduction in magnetic flux density is less than 1% over 100 years at 248 °F (120 °C).

A spring charged mechanism has over 300 total parts (many moving parts) and requires periodic maintenance.

A magnetic actuator has one moving part and requires no maintenance.
All operating mechanism functions are integrated in the magnetic actuator of the R-MAG circuit breaker. The actuator is a bistable magnet system, in which armature change-of-state is accomplished by the magnetic field of two electrically excited coils. The armature is held magnetically in the limit positions by the fields of two rare-earth permanent magnets. Switching operations are achieved by excitation of one of the two coils until the retaining force of the permanent magnets is exceeded.

Even after complete failure of the auxiliary power, the energy stored in the capacitors will allow electrical operation for 200 seconds. In the event of complete loss of control power, the circuit breaker can be tripped manually.

The armature of the magnetic actuator is linked to an operating shaft connected via insulated push rods to each of the vacuum interrupters.

Magnetic flux density distribution representation during a magnetic actuator opening operation

1 Magnetic latching in a closed position | 2 Magnetic latching plus current build up in one coil | 3 Armature reaching the open position | 4 Final open position
Low power consumption electronic control board, with flexible voltage range and alarms, control the R-MAG magnetic actuator.

Advantages of electronic controls
- Flexibility of control voltages
- Consistency of operation utilizing capacitor energy
- Built-in trip & close coil features
- Built-in breaker status indication
- Coil protection
- Ready and Not-Ready alarm

Flexibility of control voltages
- Two control boards cover all control power requirements:
  - Low voltage: 17 - 75 VDC or 21 - 52 VAC
  - High voltage: 77 - 280 VDC or 85 - 264 VAC
- Control board is independent of AC or DC
- 1 control board covers 120 VAC, 125 VDC, 240 VAC application
- Ability to test a 125 VDC breaker with 120 VAC
- Low power requirements - 93 watt normal (41 watt power optional)
  - Less than 1A at 125 VDC during capacitor charging (7 seconds)
- Plug & play removal & installation of control board assembly
  - Easy board conversion between low and high control power requirements
  - Eliminates changing of trip and close coils, motors
  - Increased safety
- Wide range of input voltages
  - Minimizes damage from voltage spikes or higher charging voltages

Consistency of operation utilizing capacitor energy
- Smaller battery system - can be minimal since there is no high instantaneous load on charging, closing or tripping
- Voltage drop is not an issue when running control power from battery system (smaller wiring can be used)
- Operate multiple breakers simultaneously
  - Sufficient energy to operate multiple breakers from station batteries simultaneously
- Constant energy source
  - Energy for closing and tripping is constant (regardless of station battery voltage) thus closing and opening speed are consistent

Using capacitors for stored energy
- The 0.1 Farad Electrolytic capacitors are designed to be operated in the temperature range of -40 °F to 185 °F (-40 °C to 85 °C)
- Extreme temperature option also available: -67 °F to 221 °F (-55 °C to 105 °C)
- Recommended capacitor replacement
  - 20 years for an average yearly temperature (in the outdoor breaker enclosure) of less than 122 °F (50 ºC)
  - 15 years for tropical climates

Built in breaker status indication
Unit-Ready and Not-Ready output contacts will provide an alarm under the following conditions:
- Drop off auxiliary supply voltage
- Low voltage on capacitor

Capacitor vs number of operations
- Open-close-open: 78 V
- Close-open: 72.5 V
- Cannot close breaker without sufficient energy to trip
- Open: 49 V
Additional features

**Manual emergency trip**
- Manual trip lever electronically interlocked to prevent closing in close block position
- 69 function
- When manually tripped, closing is electrically blocked
- When tripped, handle returns to the close blocked position
- Will not allow closing until lever is moved to normal operating position

**Embedded Poles in the 38 kV**
- High dielectric strength due to solid material insulation
- No external influences on the vacuum interrupter (shock damage, dust, humidity)
- Suitable for different climatic conditions worldwide
- Compact and robust technology (modular structure)
- Maintenance-free for life

**Summary of R-MAG advantages**
- ABB vacuum interrupters
- World’s largest manufacturer of vacuum interrupters
- Rated for 30,000 mechanical or load operations
- ABB magnetic actuator
- Eliminates all maintenance on operating mechanism
- World’s leader in magnetic actuation technology
- ABB electronic controller
- Plug and play removal and installation
- Independent of AC or DC power
- **5 YEAR FULL WARRANTY**
8.00 X 12.00 OPENING WITH REMOVABLE PLATE. CUSTOMER TO DRILL TO SUIT.

PROVISION FOR .750 DIA. HDW.

CONDUIT ENTRANCE PLATE

PROVISIONS EACH END FOR LIFTING (2.00 DIA. HOLES)

DOOR TO CONTROL COMPARTMENT

WINDOW FOR COUNTER AND POSITION IND. FAR SIDE

NOTES:
1. ALL DIMENSIONS IN [ ] BRACKETS ARE MILLIMETERS.
2. 30.00 [762] CLEARENCE ABOVE ROOF REQUIRED TO REMOVE BUSHINGS.
3. 15KV 1250A = 17.50 [444.50] STD CREEP, 28.33 [720] EXTRA CREEP
4. MAX WEIGHT: 1700 LBS [771] KG.
5. SEISMIC RATING = 0.5g PER IEEE STD 693
Descriptive bulletin | R-MAG magnetically actuated dead tank outdoor vacuum circuit breaker

Outline drawing R-MAG 15 kV 2000/3000/3700 A
27 kV 1250/2000 A

NOTES:
1. ALL DIMENSIONS IN [ ] BRACKETS ARE MILLIMETERS.
2. 30.00 [762] CLEARENCE REQUIRED TO REMOVE BUSHINGS.
3. 15KV 2000A = 27.50 [698.50] EXTRA CREEP IS STANDARD
   15KV 3000A = 18.30 [464.62] STD CREEP, EXTRA CREEP CONTACT SALES
   27KV 1250A = 27.50 [698.50] STD CREEP, 32.50 [825.50] EXTRA CREEP
   27KV 2000A = 27.50 [698.50] STD CREEP, EXTRA CREEP CONTACT SALES
4. WEIGHT: 3400 LBS (1540.2 KG) (15KV) 2900/3200A
   4000 LBS (1814.4 KG) 27KV 1200/2000A
5. SEISMIC RATING = 0.5g PER IEEE STD 69
1. ALL DIMENSIONS IN [ ] BRACKETS ARE MILLIMETERS.
2. 30.00 [762] CLEARANCE ABOVE ROOF REQUIRED TO REMOVE BUSHINGS
3. 27kV 1250A = 27.50 [698.50] STD CREEP, 32.50 [825.50] EXTRA CREEP
4. 27kV 2000A = 27.50 [698.50] STD CREEP, EXTRA CREEP CONTACT SALES
5. WEIGHT: 1430 LBS [648.64 KG] WITHOUT ELECTRONICS, WIRING, OR CTs
OUTLINE OF CABINET

NOTES:
1. ALL DIMENSIONS IN [ ] BRACKETS ARE MILLIMETERS.
2. 47.00 [1193.8] CLEARANCE ABOVE ROOF REQUIRED TO REMOVE BUSHINGS
3. MIN. WEIGHT: 2400 LBS [1089] KG.
4. SEISMIC RATING "HIGH" PER IEEE STD 693. (EXCEEDS ZONE 4)
5. 38KV 1250A = 37.00 [939.8] STD CREEP

* 3.000 VERTICAL HOLE SPACING FOR ADJUSTMENT

USE BRACES WHEN LEGS ARE FULLY EXTENDED

PROVISION EACH END FOR LIFTING (2.00 DIA. HOLES)
1. All dimensions in [ ] brackets are millimeters.
2. 47.00 [1193.8] clearance above roof required to remove bushings.
3. Min. weight: 2400 lbs [1089 kg].
4. Seismic rating "high" per IEEE Std 693. (Exceeds Zone 4)
5. 38kV 2000A = 37.00 [939.8] std creep
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14  R-MAG magnetically actuated dead tank outdoor vacuum circuit breaker | Descriptive bulletin
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### Current Transformers 1-3-5

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<td>3000/5</td>
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<td>V</td>
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<td>SPECIAL</td>
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</table>

### Current Transformers 2-4-6

Same selection available as 1-3-5

### R-MAG Enclosure

- Mild steel
- Stainless steel
- Mild steel (27 kV reduced footprint)
- Stainless steel (27 kV reduced footprint)

### Control Voltage, R-Mag Actuator Control

- Low Voltage Actuator Controller (20.4-52.8VAC or 16.8-75VDC)
- High Voltage Actuator Controller (85-264VAC or 77-280 VDC)

### Auxiliary Power

- 120VAC (must use high voltage actuator controller) 1
- 240VAC (must use high voltage actuator controller) 2
- 48VDC (must use low voltage actuator controller) 4
- 125VDC (must use high voltage actuator controller) 5

### Circuit Protection

- Molded case circuit breaker (MCB’s)
- Knife Switch
- Pullout Fuse Block
- Standard (MCB for HTR and AUX, knife SW for control)
- Special

### Control

- Basic (no relay on breaker)
- Microprocessor

### Panel Configuration

- Std ctrl switch, open/close ind lights, and Local/Remote toggle switch
- Panel with standard control switch and open/close indicating lights
- Special
- No Panel

### Bushing Terminal

- Clamp
- 4 Hole NEMA Pad
- Threaded Stud Only
- Special

*Not all combinations of options are available for all ratings. Please consult your ABB sales representative for more information.*
## Technical data

<table>
<thead>
<tr>
<th></th>
<th>Units</th>
<th>R-MAG</th>
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<tr>
<td><strong>Rated Maximum Voltage</strong></td>
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<tr>
<td>Continuous Current</td>
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<td>800/1250/2000/3000/3700²</td>
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<tr>
<td>Operating temperature</td>
<td>-50 °C and 70 °C per IEC 62271-100²</td>
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<td>Voltage Range Factor K⁺</td>
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<td>Short Circuit Interrupting Current (at Contact Part) kA, RMS, Sym</td>
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<td>12.5</td>
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<tr>
<td>Frequency</td>
<td>Hz</td>
<td>50/60</td>
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<td>Power Frequency Withstand Dry 60 Hz for 1 Min kV</td>
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<td>Power Frequency Withstand Wet 60 Hz for 10 Sec kV</td>
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<tr>
<td>Lightning Impulse Withstand (BIL) kV</td>
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<tr>
<td>Chopped Wave Withstand (kV peak) kV</td>
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<tr>
<td>Operating Duty (Standard Duty Cycle) cycles</td>
<td>Exceeds ANSI standard 0-0.3 sec-CO-3 min-CO</td>
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<td>Maximum Interrupting Time cycles</td>
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<td>Permissible Tripping Delay Y sec</td>
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<td>Closing Time cycles</td>
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<td>Reclosing Time sec</td>
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<td>Close &amp; Latch (kA Peak) kA</td>
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<td>Rated Duration of Short-Circuit @ sec</td>
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<tr>
<td>Short-Time Current</td>
<td>kA</td>
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<td>Transient Recovery Voltage (kV peak) kV</td>
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<td>Load Current Switching Capability</td>
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<td>Wire Line Charging Current A</td>
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<td>Isolated Cable Charging Current A</td>
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<td>Switching Current (A RMS) A</td>
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<td>Grounding of System and Capacitor Bank System</td>
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<tr>
<td>Capacitor Bank</td>
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<tr>
<td>Mechanical Life (No Load Operations)</td>
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Note: Please find specific R-MAG breaker vacuum bottle curves on the product instruction book.

- up to 3000 A standard breaker
- 3700 A forced air cooled breaker
- above 40 °C breaker derated per ANSI C37.010
- Per C37.09a restrike category
- Interrupter life rated for 30,000 operations when interrupting loads areless than 1 kA. For interrupting loads greater than 1 kA, consult interrupter life curves on page 3.
- For 125 kV BIL full-wave rating only

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16 R-MAG magnetically actuated dead tank outdoor vacuum circuit breaker | Descriptive bulletin
Options

**ABB test switches**

As the original FT switch manufacturer with the longest, most successful history, ABB Flexitest’s unmatched quality is the benchmark for the industry. With more than 50 years of experience, we are the test switch manufacturer with the largest installed base in North America. ABB’s Flexitest test switch’s perfected design offers the highest quality, leaving nothing to chance. You can’t afford less than perfect. ABB Flexitest is the original FT - there is no equivalent.

**Relion® 615 series**

The Relion® product family offers the widest range of products for the protection, control, measurement and supervision of power systems. To ensure interoperable and future-proof solutions, Relion products have been designed to implement the core values of the IEC 61850 standard. You can benefit from ABB’s leading-edge technology, global application knowledge and experienced support network.
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