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Medium-voltage, vacuum generator circuit breakers

Tested to IEEE C37.013 and suitable for generators up to 200 MW



Siemens offers a full line of IEEE C37.013 qualified medium-voltage vacuum generator circuit breakers for voltages up to 24 kV and generators up to 200 MW for both indoor and outdoor applications.

Features and benefits

- Eco-friendly vacuum interruption, low carbon footprint
- Low maintenance vacuum interrupters with visible wear indication

- No gas handling equipment required
- Up to 50 full-fault interruptions
- 10,000 operations mechanical endurance
- Significantly lower cost than gas circuit breakers.

Applications

- Gas turbines
- Hydro-generators
- Pumped storage
- Concentrated solar
- Biomass.


Overview

Circuit breakers applied to generator switching applications are subject to conditions quite different from those of a normal distribution circuit breaker used in industrial, commercial and utility systems. Distribution circuit breakers, whether of the outdoor substation type or of the drawout type for use in metal-clad switchgear, conform to IEEE C37.04 (basis of ratings), IEEE C37.06 (preferred ratings), IEEE C37.09 (testing) and IEEE C37.010 (application).


Circuit breakers applied on generators 10 MVA and above fall under IEEE C37.013a-2007, which recognizes the application differences between normal distribution circuit breaker switching and generator circuit breaker switching.

Answers for infrastructure.

Description	Unit	Small machines 10 MW to 80 MW	Mid-range machines 60 MW to 200 MW
Maximum design voltage	kV	15	17.5/24
Continuous current	A	1,200/2,000/3,000/4,000	3,000/4,000/5,000/6,000
Rated dielectric withstand			
■ Power frequency	kV (1 min)	38	50/60
■ Impulse	kV crest	95	110/125
Rated duty cycle	----	CO-30 min-CO	CO-30 min-CO
Rated short-circuit current			
■ System source	kA	40/50/63	50/63/72
■ Generator source	kA	20/25/31.5	25/31.5/36
Asymmetrical interrupting			
■ %dc component	%	73/61/61	75/65/65
■ Asymmetrical (ref)	kA rms	57.5/72/83	73/86/98
Short-circuit current (3 s)	kA	40/50/63	50/63/72
Close and latch capability	kA peak	110/137/164	137/164/198



Type GMSG-GCB drawout



Stationary type 3AH38 (3,000 A or 4,000 A)

Delayed current zeroes

One of the distinguishing characteristics of applications to generator switching is that generators have a limited rotating inertia and slow down during short circuits. This introduces a problem. The ac component is no longer a constant rms value, but, in fact, decays. This condition is most severe with low-inertia machines, such as gas turbines, where the time constant of decay of the ac component can be faster than the corresponding dc decay. Under this condition, the superposition of the dc component on the ac component will result in a potentially long period in which the actual fault current does not pass through zero. This is a problem as circuit breakers, including vacuum circuit breakers, actually interrupt as the current passes through a normal current zero. This phenomenon is referred to in IEEE C37.013 as "delayed current zeroes" and is a condition for which the performance of the generator circuit breaker must be determined by testing.

Higher X/R ratio

Another difference is in the values of the system X/R ratio between distribution applications and generator applications. The basis of interrupting ratings and testing for distribution circuit breakers is a system X/R ratio of 17 (at 60 Hz) that gives a time constant of dc decay of 45 ms. Thus, in a distribution application, the dc component is nearly completely decayed after just a few cycles.

However, the basis of rating for a generator circuit breaker is a system X/R ratio of 50 (at 60 Hz), which gives a time constant of dc decay of 133 ms, and hence the dc component decays very slowly. This means that the dc component of the current at the instant of interruption is much larger for a generator application than it would be in a distribution application.

Transient recovery voltage (TRV)

Another aspect of a generator circuit breaker application is that the transient recovery voltage (TRV) across the contacts as the interrupter opens is much greater than for a distribution circuit breaker. For typical 15 kV distribution circuit breakers, the rate of rise of TRV during a symmetrical fault interruption at 100 percent of rating is 0.92 kV/μs. In contrast, for generator circuit breaker applications, the corresponding value is 3.2 to 4.5 kV/μs for systems ranging from 10 MVA up to 400 MVA (based on transformer size).

For an in-depth view of medium-voltage generator applications, please refer to Siemens TechTopics 44, 71, 72 and 73 at www.usa.siemens.com/techttopics.

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