

TechTopics Topic: "Bus Bracing" in Metal-Enclosed Switchgear

For decades, users and specifiers of Metal-Enclosed Power Circuit Breaker Switchgear have used the phrase "bus bracing" to define a specific level of mechanical strength for the bus system of the switchgear. However, this term has not historically been used in any of the standards that contain the major requirements for Metal-Enclosed Switchgear. Further, no specific rating for bus bracing is specified in the standards. This problem with ill-defined terms has been confusing for years. The purpose of this issue of TechTopics is to discuss the requirements for switchgear buses and to define what is meant when the term "bus bracing" is used.

The principle standard applicable to Metal-Enclosed Power Circuit Breaker Switchgear is ANSI/IEEE C37.20.1-1993. As it relates to the bus ratings, this standard defines several ratings:

- **Rated short-circuit withstand current:** This is the symmetrical current that the switchgear bus must withstand for a test duration of at least four cycles. During the test to verify this rating, the peak current must be at least 230% (for unfused circuit breakers) or 216% (for fused circuit breakers) of the smallest frame size circuit breaker used in the assembly.
- **Peak withstand current:** This is not strictly a rating, but it is the peak current value (230% or 216%) that must be attained during the rated short-circuit withstand current test described above.
- **Rated short-time withstand current rating:** This is the average symmetrical current that the switchgear must be able to withstand for two periods of 0.5 seconds, separated by a 15 second interval of zero current.

How do the above ratings relate to the ratings of the components used in the switchgear assembly? As you would expect, the ratings directly correlate to produce a coordinated system:

- **Peak withstand current:** Historically, the standards have not stated the peak current withstand rating as an explicit rating. Instead, this performance requirement has been embedded in the testing requirements for the circuit breakers and the switchgear, so that the user would not have be concerned with it. The peak withstand current required of the switchgear corresponds directly to the prospective peak current for the circuit breaker when it is tested in accordance with ANSI C37.50 (Reference clause 3.9.3.3.3 for 230% peak current for unfused circuit breakers, and 3.9.3.3.4 for 216% peak requirement for fused circuit breakers).
- **Short-time current rating:** The switchgear requirement corresponds directly to the short-time test requirement for unfused circuit breakers in ANSI C37.50 (reference clause 3.10.4). Short-time ratings are not applicable to fused circuit breakers as the fuse will not allow the current to flow for the duration of a short-time test.

OK, so much for theory. What are the equivalent ratings?

Circuit breaker rating or characteristic	Units	Value	Coordinating Switchgear rating or characteristic
[Unfused Circuit Breakers] Short-Circuit (Interrupting) Current (C37.13-1990, clause 5.6.1)	kA sym	100% = I _{SC}	Short-circuit withstand current (C37.20.1-1993, clauses 4.4.4 & 5.2.4)
[Fused Circuit Breakers] Short-Circuit (Interrupting) Current (C37.13-1990, clause 5.6.2)	kA sym	100% = I _{SC}	Short-circuit withstand current (C37.20.1-1993, clauses 4.4.4 & 5.2.4)
[Unfused Circuit Breakers] Short-Time Withstand Current (C37.13-1990, clause 5.5)	kA sym	100% of I _{SC}	Short-time withstand current (C37.20.1-1993, clauses 4.4.3 & 5.2.3)
[Fused Circuit Breakers] Short-Time Withstand Current (C37.13-1990, clause 5.5)	kA sym	Not applicable	Not applicable (C37.51-1989, clause 4.7, paragraph 4)
[Unfused Circuit Breakers] Making current (C37.50-1989, clause 3.9.9)	kA peak	230% of I _{SC}	Peak current requirement during the short-circuit withstand test (C37.20.1-1993, clause 5.2.4)
[Fused Circuit Breakers] Making current (C37.50-1989, clause 3.9.9)	kA peak	216% of I _{SC}	Peak current requirement during the short-circuit withstand test (C37.20.1-1993, clause 5.2.4)

Finally, the “bus bracing” is most commonly considered to be short-circuit current rating of the switchgear, expressed as a symmetrical current. However, some users may wish to determine the equivalent values in other terms. The equivalent values are:

Circuit Breaker Type	Rms (sym)	Peak	Rms (asym)	X/R and PF of test circuit
Unfused	100%	230%	133%	X/R = 6.6 PF = 15%
Fuses	100%	216%	124.7%	X/R = 4.9 PF = 20%

The values for the asymmetrical current conversion shown in the fourth column are obtained from Table 2 in ANSI C37.26-1972. The corresponding values for the X/R ratio and Power Factor are shown in the fifth column of the table above.

Regardless of how the bus bracing requirement may be stated, the same performance is required of the switchgear buses and connections.

The required short-circuit withstand current for the switchgear assembly depends on the assortment of circuit breakers included in the assembly. The requirement is that the short-circuit capability of the switchgear assembly is determined by the short-circuit capability of the ‘poorest’ circuit breaker included in the assembly (which is the ‘weak link’). In more formal terms:

- For switchgear assemblies with no fused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the circuit breaker with the lowest short-circuit current rating in the assembly.
- For switchgear assemblies with only fused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the fused circuit breakers used in the assembly.
- For switchgear assemblies with both fused and unfused circuit breakers, the rated short-circuit withstand current is the short-circuit current rating of the unfused circuit breaker with the lowest short-circuit current rating in the assembly.

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