



TechTopics No. 21

“Bus bracing” in metal-clad switchgear

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For decades, users and specifiers of metal-clad switchgear have used the phrase “bus bracing” to define a specific level of mechanical strength for the bus system of metal-clad switchgear. However, this term is not used in any of the standards that contain the major requirements for metal-clad 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-clad switchgear is ANSI/IEEE C37.20.2-1999. As it relates to the bus ratings, this standard defines several ratings:

- **Rated momentary-withstand current** – This is the maximum rms total (asymmetrical) current the switchgear bus must withstand, and is measured at the major peak of the maximum cycle of the maximum offset phase. The test to verify this rating requires a test duration of at least 10 cycles of power frequency. During this test, the peak current at the major peak in the maximum cycle must be at least 260 percent of the rated short-time current of the switchgear.
- **Rated peak-withstand current** – This is not strictly a rating, but it is the peak current value (260 percent) that must be attained during the momentary withstand-current test described above.

- **Rated short-time withstand current** – This is the average symmetrical current that the switchgear must be able to withstand for a period of two seconds.

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

- **Momentary-current and peak-withstand current ratings** – Historically, the standards specified a momentary-current (rms asymmetrical or rms total current) rating. In fact, the NEC® 490.21 (A)(4) still uses “momentary” to designate the maximum asymmetrical current. However, for many years, the ANSI/IEEE C37-series of standards have been moving away from the concept of the asymmetrical rms current towards the concept of the peak current. The reason for this is that it is the magnitude of the peak current that determines the maximum forces applied to the conductors. Because of this shift in the philosophy of the standards, the equivalent requirements are stated somewhat differently in the various standards.

Circuit breaker rating or characteristic	Units	Value	Coordinating switchgear rating or characteristic
Short-circuit (interrupting) current (ANSI/IEEE C37.04-1999, clause 5.8.1)	kA sym	100% = I _{ST}	Short-time withstand current (ANSI/IEEE C37.20.2-1999, clause 5.4.6)
Short-time withstand current (ANSI/IEEE C37.04-1999, clause 5.8.2.3.b)	kA sym	100% of I _{ST}	Short-time withstand current (ANSI/IEEE C37.20.2-1999, clause 5.4.6)
Maximum permissible tripping delay (ANSI/IEEE C37.06-2009, Table 1)	Seconds	2 s	Short-time withstand current duration (ANSI/IEEE C37.20.2-1999, clause 5.4.6)
Closing and latching current (ANSI/IEEE C37.04-1999, clause 5.8.2.3.a)	kA peak	260% of I _{ST}	Peak withstand current (ANSI/IEEE C37.20.2-1999, clause 5.4.3)
Closing and latching current (calculated rms current corresponding to the peak current)	kA rms	155% of I _{ST}	Momentary current (ANSI/IEEE C37.20.2-1999, clause 5.4.3)
Close and latch current duration (ANSI/IEEE C37.09-1999, clause 4.8.4.1)	Cycles	10 cycles	Momentary current duration (ANSI/IEEE C37.20.2-1999, clause 5.4.3)

- For circuit breakers rated on the “constant MVA” basis (refer to TechTopics No. 4), the momentary rating is most often expressed in rms asymmetrical amperes and is the “closing and latching” rating. However, the closing and latching rating may be specified in peak amperes. The rms asymmetrical rating was listed in ANSI C37.06-1979, while the peak current value was used in ANSI C37.06-1987.
- For circuit breakers rated on the “constant kA” basis (refer to TechTopics No. 4), the peak withstand current corresponds to the closing and latching rating of the circuit breaker, in ANSI C37.06-1997 or ANSI/IEEE C37.06-2009, expressed in peak amperes.
- Short-time current rating – Here, the standards have been consistent over time. The short-time current rating of the switchgear buses and connections must match the “maximum permissible tripping delay” value for the associated circuit breakers (see clause 5.8.2.3 of ANSI/IEEE C37.04-1999 and Table 1 of ANSI/IEEE C37.06-2009), which is two seconds for the circuit breakers used in metal-clad switchgear.

Note: The standard allows use of devices in the switchgear that have a rated short-time current duration of less than two seconds. Most notably, low-ratio current transformers or wound-type current transformers may fall into this category. The protective device coordination study must take these reduced durations into account.

What are the equivalent ratings? The following table is based on the “kA-rated” circuit breakers in accordance with the coordinated standards issued in 1999-2000.

Finally, the “bus bracing” is most commonly considered to be the momentary current expressed in rms asymmetrical current, because this equates to the historic usage of the “momentary” term. However, bus bracing may be expressed either in rms asymmetrical current (155 percent of I_{ST}) or in peak current (260 percent of I_{ST}), as either form demands the same performance from the switchgear buses and connections.

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