Data Bulletin

What You Need to Know about 200,000 Ampere Available Fault Currents

IS IT REAL?

For several years service entrance equipment and in some cases entire jobs have been specified with 200 kA available fault current. Many people in the electrical industry have questioned whether available fault currents are actually that high or if 200 kA fault current was specified due to conservative calculations, the desire to provide future flexibility, limited transformer data at the time the specification was written or other related issues.

Many times specifying engineers and system designers cannot get accurate transformer or network data and must provide an educated estimate of maximum available fault current. Other times utilities provide information indicating oversized transformers or provide estimates based on the assumption that lower impedance transformers may replace existing transformers.

Let's look at some factors affecting available fault current and how Square D Company offers unique solutions to applications with different levels of fault current.

Transformers

As we know, the largest factor relating to available fault current is impedance related to transformer size and impedance. Information from Square D transformer sales and NEMA data indicates that for 240 V and 480 V transformers greater than 500 kVa, the standard 5.75% impedance is dominant. Manufactuers vary from 1.3% to 5.8% impedance at 500 kVA, but from 750–3000 kVA the variation was only 5% to 5.75%. Smaller transformer impedances range from 1% to 6.5%.

During the past ten years, there has been no evidence of trends toward significantly lower transformer impedance. Available fault currents for single transformer installations of 480 V three-phase systems with 100% motor contribution would range from 14.4 kA for 500 kVA to 77.2 kA for 3000 kVA. See the table below.

Table 1: Available Fault Currents for Standard Three-phase Transformers at 480 Vac (Fluid-filled and Ventilated Dry Types)

kVA/ Impedance	Full Load Amperes	Secondary Short-circuit Currents (RMS Symmetrical Amperes)	Motor Contribution (Amperes)	Combined Total Short-circuit current (Amperes)
500/5.0%	601	12000	2400	14400
750/5.75%	902	15700	3600	19300
1000/5.75%	1203	20900	4800	25700
1500/5.75%	1804	31400	7200	38600
2000/5.75%	2406	41800	9600	51400
2500/5.75%	3008	52300	12000	64300
3000/5.75%	3613	62800	14400	77200
3500/5.75%	4215	73301	16800	90101

On 208 Y/120 V or 240/120 V three-phase systems, lower impedance increases the neutral current when harmonics producing non-linear loads are present. Very low impedance transformers are not practical for these applications.

Network Systems

Several major U.S. cities had transformer networks built which can deliver very high fault currents (up to 200 kA at 208 V and over 150 kA at 480 V). Then there were trends to move away from these networks because large portions of a city may be blacked out during a fault. In the early 1990s, Square D estimated that less than 5% of the new systems sold went into areas with networked systems. It appears that this number may be decreasing, but these systems do exist and must be considered when designing a system.

Paralleling of Transformers

Some utilities made a decision to stock a maximum size transformer. Transformers are then connected in parallel for larger systems. Available fault currents can be up to 200 kA. These installations are few and can be considered to be represented in less than 5% of the systems.

Cogeneration

Cogeneration can increase the available fault current. Cogeneration, however, is most commonly used to control peak loads and only leads to negligible increases in available fault current. Any cogeneration increases in available fault current must be considered during system design.

SPECIFICATIONS

Due to conservative calculation or the assumption that lower impedance or larger kVA transformers may replace existing transformers, some utilities may overestimate available fault current. When the service entrance transformer is user owned, the consulting engineer has a better opportunity to determine the actual available fault current and design the system to minimize cost and maximize performance.

SIGNIFICANCE OF 200,000 AMPERE AVAILABLE FAULT CURRENTS

Circuit Breaker—Ampere Interrupting Rating (AIR)

As we have seen by analyzing transformer sales data, networks, parallel systems and cogeneration, approximately 95% of service entrance systems have available fault currents of less than 85 kA at 480 V. The fact remains that around 5% of the jobs are in the 150 to 200 kA range and those systems must be designed with this capability.

Most circuit breaker manufacturers offer some products with 150 kAIR and 200 kAIR. Square D is the only manufacturer offering American National Standards Institute (ANSI) rated MASTERPACT® NW low-voltage power circuit breakers tested to 200 kAIR at 508 V (480 V nominal) without fuses. All other manufacturers must use current-limiting fuses ahead of their circuit breakers to protect them. The fuses required by these manufacturers add cost and size and make the installation complicated to maintain by the customer.

Equipment—Short-circuit Current Rating (SCCR)

With interrupting ratings in the 200 kA range, it is equally important to make sure the equipment specifications meet the application. The bus bracing and enclosure integrity must be appropriate for the high magnetic forces and heat associated with interruptions of high level short circuits. Square D POWER-ZONE® 4 switchgear carries a 200 kA SCCR.

CONTRASTS OF LOW-VOLTAGE POWER CIRCUIT BREAKERS (LVCPBs)

Let’s explore some of the differences between standard LVBCBs and the new MASTERPACT NW circuit breaker from Square D. Standard LVPCBs (4000 and 5000 A frames) have been tested for systems up to 85 kAIR at 508 V while lower-rated frame sizes (800–3200 A) have been tested for 30, 50 or 65 kAIR. See the table below. Many electrical systems have available fault currents between 65 kA –85 kA. An application using a 3000 kVA transformer would have available fault current of 77 kA (see table 1). A standard 4000 A main LVPCB with 85 kAIR would be acceptable for use on this system. Branch 800, 1600, 2000 and 3200 A LVPCBs would not be acceptable for use on this system because their AIR ratings are 30, 50 and 65 kA. The only solution would be to use 4000 A frame breakers with lower sensor ratings or fused LVPCBs that are rated for 200 kAIR. Both of these solutions add cost and/or size to the installation.

Table 2: Standard DS Low-voltage Power Circuit Breaker Frame Sizes and Ratings

DS LVPCB	Frame Size (Amperes)	Voltage (ac) 480 V Nominal	AIR
DSII-308	800	508	30,000
DSII-508	800	508	50,000
DSII-608	800	508	65,000
DSII-516	1600	508	50,000
DSII-616	1600	508	65,000
DSII-620	2000	508	65,000
DSII-632	3200	508	65,000
DSII-840	4000	508	85,000
DSII-850	5000	508	85,000

MASTERPACT NW LVPCBs are designed and tested for application in the entire range of available fault current. In the same application as the example above, the MASTERPACT NW circuit breaker is available in 85 kAIR from 800 A frame through 5000 A frame. The MASTERPACT NW circuit breaker offers solutions in all applications while maintaining cost efficiency and the smallest footprint available.

Table 3: MASTERPACT NW Circuit Breaker Frame Sizes and Ratings

MASTERPACT NW Circuit Breaker	Frame Size (Amperes)	Voltage (ac)	AIR
N1	800 and 1600	508	42,000
H1	800, 1600, 2000 and 3200	508	65,000
H2	800, 1600, 2000, 3200, 4000 and 5000	508	85,000
L1	800, 1600, 2000 3200, 4000 and 5000	508	200,000 (without fuses)

We have identified the need, in a small number of applications, for a distribution system that is tested to handle high available fault currents above 150 kA. Standard LVPCBs have been tested for systems up to 85 kAIR. LVPCBs by necessity have been designed to provide high withstand ratings. High withstand ratings allow LVPCBs to remain closed, carrying large amounts of current, while downstream feeders and branch circuit breakers open to clear the fault. This provides for maximum uptime and maintains continuity of service.

Unfortunately, the very design of the contacts and mechanism that enables the circuit breaker to provide the high withstand capacity makes it impossible for the standard LVPCB to survive higher level fault currents in the 150–200 kA range.

The traditional solution has been to apply large current-limiting fuses ahead of the LVPCB to protect the circuit breaker during faults above its ampere interrupting rating. This solution worked with existing technology but caused other problems:

1. The size of the installation is much larger.
2. The fuses melt quickly during high short-circuit faults which effectively eliminates the circuit breaker short-time withstand rating. This affects the coordination capability of the fuse/circuit breaker.
3. The current-limiting fuses have to be sized high enough to prevent interference with coordination during the more common low-level faults.
4. With the fuses sized higher, they cannot provide protection downstream of the main circuit breaker for other components in the circuit.
5. The cost of the installation and the inconvenience of replacing fuses increase maintenance costs and can decrease the service life of the installation.
6. Fuse connections add impedance and additional heat into the system.

The Square D MASTERPACT NW ANSI rated LVPCB is designed and tested for use on circuits with 200,000 A of available fault current without fuses. The circuit breakers are tested both separately and when installed in POWER-ZONE 4 switchgear. These tests prove, even during a massive 200,000 A fault, that the circuit breaker and switchgear function normally to protect the electrical system. The MASTERPACT NW LVPCB maintains up to a 100,000 A short-time withstand rating which allows the circuit breaker to maintain coordination.

Standard LVPCVBs

Examples of standard LVPCBs: Square D DSII, Cutler-Hammer Magnum DS, GE WavePro and Siemens RL; maximum interrupting ratings are 85 kAIR and 100 kAIR.

Pros:

- Proven technology
- Large installed base
- Ratings match some applications

Cons:

- Lower rating than some applications require (5% of applications require 150 kAIR and higher)
- Fault clearing times of approximately 56 msec. (DSII-850 635 V @ 85 kA)

Fuses Ahead of the LVPCB

Examples of circuit breakers requiring fuses: Square D DSLII, Cutler-Hammer DSLII, GE Wave Pro (WPF) and Siemens RL; maximum interrupting rating 200 kAIR.

Pros:

- High ratings
- Fuses protect circuit breaker
- High-level fault clearing times of approximately 10 msec.

Cons:

- High cost
- Large installation requiring more space in the electrical room
- Maintenance problems with replacing blown fuses
- High service life costs
- Fuses protect circuit breaker during high-level short circuit; they must be sized high enough to prevent interference with coordination during the more common low-level faults
- With the fuses sized higher, they can not provide protection downstream of the main or feeder circuit breaker for other components in the circuit
- Fuse connections add impedance and additional heat into the system

MASTERPACT NW LVPCB (New Technology)

Examples of new technology circuit breakers that do not require fuses: ONLY Square D and Merlin Gerin MASTERPACT NW circuit breakers; maximum interrupting rating 200 kAIR without fuses.

Pros:

- State of the art technology based on proven MASTERPACT circuit breaker design
- High ratings (200 kAIR at 508 V without fuses)
- High-level fault clearing times of 9 to 11 msec.
- Lower cost than fused circuit breakers
- Smallest installed volume and footprint
- UL witnessed ANSI tests proving high-level fault performance

Conclusion

MASTERPACT NW circuit breakers provide the best solution for high available fault current applications. As we have seen, Square D estimates that the majority of all service entrance installations (95%) have available fault currents of less than 85 kA at 480 V. In these cases lower AIR circuit breakers can be specified at minimal cost while maintaining performance and safety. In systems with available fault currents in the 150–200 kA range where networked systems, paralleled transformers or cogeneration are present, MASTERPACT NW low-voltage power circuit breakers installed in POWER-ZONE 4 switchgear offer the best solution. MASTERPACT NW circuit breakers and POWER-ZONE 4 switchgear are designed and tested for 200 kA AIR and 200 kA SCCR at 508 V without the use of fuses and provide the necessary performance in a smaller footprint with reduced installation and maintenance costs.

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