Paralleling and or Fan Cooling Low Voltage Power Breakers – A Higher Continuous Current Solution

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Abstract:

For systems that require continuous current ratings higher than the standard product capabilities, there are two additional solutions to consider:

1. Cooling fans can be added to the circuit breaker cell, allowing increased current through the breaker.
2. Double wide breakers can be used.

Forced-air cooling using additional fans is a relatively standard way of addressing higher continuous current requirements.

With that said, the art of building switchgear assemblies is increasingly refined; today's smaller, lighter circuit breakers and modern design practices make it easier and more economical to connect two circuit breakers together in parallel as one breaker product. These are often called double wide breakers. Regardless of the circuit breaker method selected to meet the continuous current requirements, special attention must be given to a number of switchgear assembly design areas.

Introduction:

This paper focuses on achieving higher continuous current ratings. In general, fan cooling increases the current ratings of a given configuration. Typical fan cooling configurations include:

a) One 4000A double narrow circuit breaker can carry 5000A with fan cooling. ANSI.

b) One 5000A double wide circuit breaker can carry 6000A with fan cooling. ANSI.

Please note each manufacturer must test their design in order to demonstrate that the performance meets the assigned rating via fan cooling. In addition, if an OEM incorporates this design they must also test the breaker in their enclosure to show the capability. Since each enclosure design may have differences in design and or cooling.

The breakers are shipped with integral current transformers that are rated for the fan cooled rating. So the 4000A double narrow breaker is actually sold as a 5000A double narrow fan cooled (FC) breaker. The only changes in general for this product are the sensors, rating plugs, nameplates, and code pins. The fans are what provide the extra cooling ability.

Cooling Fans Increase Circuit Breaker Ratings:

To illustrate how fans increase ratings, consider a standard 5000A low voltage power circuit breaker. Using a cooling fan, this circuit breaker can carry 6000A without overheating (Figure 1). The enclosure needs to have the necessary airflow arrangement that allows it to pass the thermal test requirements without exceeding the temperature limits specified in the standards. The enclosure must have bus bars able to carry the full rating of the product.

If the product is always used at the full capability of the product then the fans must always be on. But in some cases there is only a short duration that the full thermal rating is required. For these cases the fan is only temporarily used at higher currents. Then it is possible to have the fans wired to turn on only when required. All of the necessary control equipment is included to start the fans when the temperature or current indicate the fans are needed, and to operate them until the temperature or current indicate the fans are no longer needed. If the flow of cooling air becomes insufficient or is lost. Alarm circuitry can alert personnel of the loss of a fan so corrective actions can be taken to resolve the issue.

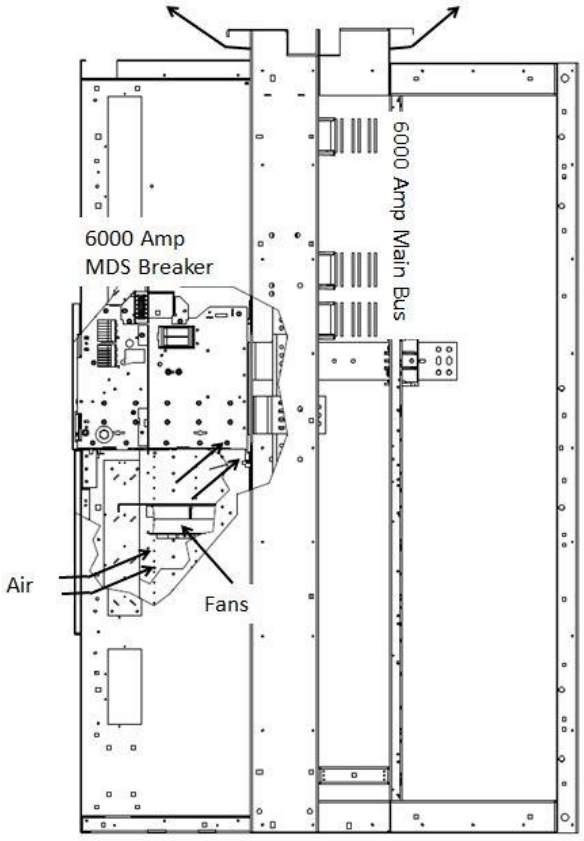

Fig 1 – Typical Low Voltage Enclosure Assembly Unit with a Magnum Low Voltage Breaker Fan Cooled to Allow 6000A Continuous Current

Double Wide Circuit Breakers to Achieve Higher Ratings (Parallel Breakers Combined Together):

Connecting circuit breakers in a parallel arrangement also provides for higher continuous ratings. Eaton has opted to connect the breakers via a common pole shaft. So the two breakers are combined to make one common breaker. In the industry these breakers are often called double wide (DW) breakers. This name is used to describe two breaker current paths combined together within one breaker frame. They share integral trip units and a common mechanism. These breakers can be configured AABBCC or ABCABC. AA is an identification reference to phase A1 and phase A2 connected together in the cassette. So they act as one phase together. Double narrow breakers (DN) are very similar to double wide breakers. They just start with two narrow frames instead of two standard frames.

A parallel approach requires that steps are taken within the breaker to balance the primary current flowing through each circuit breaker. One over-current protection system should be provided for the complete circuit breakers. That is why Eaton chooses to make double wide (DW) or double narrow breakers (DN) as one breaker. So that they share a common mechanism and integral trip unit (relay).

Main bus construction should also be configured so as to ensure balanced impedances in each phase of the circuit. Finally, it is critical that the design is verified by continuous current thermal tests.

Fig 2 – Eaton Double Wide (DW) breaker. With fan cooling this unit can carry 6000A continuous current. Without fan cooling it can carry 5000A.

Fig 3 – Eaton Double Wide (DW) breaker. Rear fixed mounted breaker view. Showing AABBCC identification of the phases.

Fig 4 – Eaton Double Narrow (DN) breaker. With fan cooling this unit can carry 5000A continuous current. Without fan cooling it can carry 4000A.

Fig 5 – Eaton standard frame breaker. This breaker can carry 3200A without any fan cooling. The narrow frame can carry 1600A without any fan cooling.

Fig 6 – Eaton current sensors and rating plugs. These components are integral to the breaker.

Additional Considerations:

Depending on the desired rating and the size of the enclosure. It is possible to fan cool a single standard wide or narrow frame breaker. This option would have to be tested and proven via the manufacturer. And then re-confirmed via an OEM via separate additional testing. Since new sensors and rating plugs may be required.

Conclusions:

No matter which solution is selected to increase the continuous current rating, special attention must be given to:

1. Selection of circuit breakers with required interrupting capabilities.
2. Breakers with thermal capability;
3. Design of electrical controls and protection scheme;
4. Design of switchgear assembly;
5. Documented testing;
6. Economics.

When a standard size circuit breaker with the preferred ratings does not meet the continuous current requirements for an application, solutions involving fan cooling, double wide breakers, and or a combination these methods can be made available to meet specific application requirements.

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