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Static Micro-ohm Resistance Readings Across Metal-Enclosed Busway

White Paper

Operational life of all forms of electrical power distribution equipment is dependent on robust design and proper manufacturing and installation. While manufacturers and installers agree that installations of metal-enclosed busway should be verified in the final installation, the process to validate such installations has been debated.

Manufacturers of metal-enclosed busway recommend following the guidance offered by NEMA BU 1.1, "General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less." The key tenants of NEMA BU 1.1 for verifying a proper installation are:

- Observation that the phase sequencing matches that of connected equipment,
- Verification that ventilation openings and drains are unobstructed,
- Verification that the joints have been torqued to manufacturer specifications, and
- Dielectric performance has been verified though insulation resistance testing

The InterNational Electrical Testing Association (NETA) includes these same recommendations in their acceptance testing standard, NETA "Acceptance Testing Specifications," with the following additions:

- Resistance measurement of the conductors
- Thermographic survey of the conductors

While on the surface these tests appear to be beneficial, there are some difficulties associated with interpreting the results of these observations, which make them generally impractical for determining the health of an installation.

1. Application of switches, disconnects, and circuit breakers

   Manufacturers use a variety of switches, disconnects, and circuit breakers as means of isolation for tap-off or plug-in connections for branches off the busway trunks. These devices utilize internal main contacts that are self-cleaning when operated under load. Particularly for new switching devices, but applicable for any switching device that has been left open for a period of time, any contaminants are removed during loaded operations. In order to maintain this functionality in power and molded case circuit breakers it is important that the users of such circuit breakers not attempt to adjust, clean, dress, or polish the main contacts.

   Siemens Industry (as well as other manufacturers of switching devices) does not recommend performing milli-ohm or milli-volt drop tests across switching contacts because it has been shown that such tests are not a reliable or accurate method of determining the suitability of a given switch for its intended application.

   The resistance of the main current path (including the contacts) in a switch is variable. Contact resistance, and the measurement of contact resistance is affected by:

   - Climate
   - Number and magnitude of past interruptions
   - Foreign material between the contacts
   - Oxidation of contact surfaces
   - Assembly tolerances
   - Where and how the readings are taken

   Static micro-ohm or milli-volt drop readings and thermographic observations are highly sensitive to all the previously mentioned criteria — a known and acceptable condition to Siemens and other manufacturers of switching devices.

2. Variations of connection methods

   Busway is composed of phase conductors, as well as neutral and ground conductors. The phase conductors are connected through disconnect switches (as previously discussed), however neutral and ground conductors are solidly connected and bypass these switching devices.

Bypassing the switching devices will result in static resistance readings associated with the neutral and ground conductors dramatically different than that of the phase conductors.

3. Variations of conductor geometry and length

   Busway is composed of phase conductors, as well as neutral and ground conductors are varying geometry, cross-sectional area, and length. Each of these aspects will affect the static resistance measurements and thermographic observations of the busway conductors. Variations in conductor design and paths are not readily observable due to their nature of being encapsulated within the busway segments.

Contact resistance in the order of magnitude that is measured in the field (20 — 200 micro-ohms), aside from being variable, is negligible both in theory and in practice, as are the phase-to-phase differences frequently measured. The NETA document "Acceptance Testing Specifications" makes an arbitrary statement as to the allowable tolerance of this measurement when no tolerances are stated by the manufacturer. As applied to Siemens devices, this arbitrary pass/fail criterion has no basis in the practical operational environment of the electrical equipment.

For the reasons above, Siemens Industry neither publishes any tolerances for, nor recommends the testing of static micro-ohm or milli-volt drop for any busway products.

Siemens types XJ-L HD and Sentron Busway are designed, tested, and third-party certified to UL 857.

Siemens Industry recommends that NEMA BU 1.1 be followed for matters regarding, storage, installation, operation, and maintenance. Static resistance measurements and thermographic imaging cannot detect if joints have been over-tightened[1] and, as discussed, inherently invoke many potentialities for false reporting of loose connections.

Siemens Industry does not accept the NETA "Acceptance Testing Specifications" as an accurate means of validating the quality or operational performance of its busway products. Any test report or claim stating that a Siemens busway is not suitable for its intended application or service on the basis of contact resistance or thermographic observations, will not be considered acceptable evidence of nonconformity for warranty action by Siemens. Any other conformity issues or conditions will be considered under the Siemens Industry Standard Terms and Conditions of Sale.

[1] Over-tightening of joints can result in cold-flow of the conductor material as the joint is heated. This plastic deformation can result in loosening the joints during thermal cycling (heating and cooling cycles of the equipment caused by temperature shifts and changes in the loading conditions).

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