

Grounding and equipotential bonding

Development and verification of concepts for grounding and equipotential bonding systems in power networks

At a glance

High-voltage systems require a grounding system that will reliably protect people from the effects of short circuits to earth and ground faults.

In low-voltage systems – besides adhering to the requirements for disconnection – equipotential bonding and protective equipotential bonding in particular are fundamental protective measures against indirect contact.

During operation and also in case of faults, electrical energy systems have an electromagnetic impact on the environment. To ensure faultless operation of equipment within and outside of the system, equipotential bonding through the grounding system is an important measure, even for high frequencies.

Buildings and electrical equipment require lightning protection systems to minimize the risk of personnel injury and also system outages or even system puncture. Equipotential bonding and grounding are important elements of a lightning protection system.

Siemens Power Technologies International (Siemens PTI) offers the following services for all kinds of electrical supply systems, for instance industrial, railway or power utility systems:

- measurement of electric soil resistivity

- planning of grounding and equipotential bonding systems
- testing of grounding systems with various measuring techniques (e.g. current-voltage method according to EN 50522 or IEEE81.2)
- evaluation of grounding concepts and grounding systems
- simulation of grounding systems and calculation of the surface potential
- calculation of zero-sequence currents in electricity supply systems as well as current distribution within the grounding system
- design of lightning protection concepts (e.g. IEC62305, IEEE998)
- check of lightning protection systems
- fault clearing

The challenge

Grounding and equipotential bonding systems are complex electrical systems with components from civil engineering, mechanical engineering, high- and low-voltage power engineering, as well as control and communication technology.

Various national and international standards define the requirements for

grounding, equipotential bonding and lightning protection systems.

Following the technical and economical requirements, the grounding system has to be designed to ensure personnel safety while at the same time maintaining high system availability.

In this respect expert knowledge is required during the following tasks:

- new system installations
- verification of adherence to admissible touch voltage
- modification of an existing system, e.g. system extension or replacement of equipment
- changes to the connected electricity supply systems
- fault clearing

Our solution

For the development of individual grounding concepts and fault clearing, Siemens PTI can draw upon profound experience and competencies in the following fields:

- technical and physical relations in grounding and equipotential bonding systems
- national and international standards
- powerful software tools for the calculation of relevant electrical parameters
- development of concepts for electrical power supply systems, such as power stations, substations, converter stations, offshore systems, magnetic levitation (maglev) trains, steel mills, automotive industry, chemical industry, mining

- testing and evaluation of any kind of grounding system worldwide

Application example 1

This example shows a standard procedure for the design of a grounding system for a high-voltage system – in this case of a photovoltaic system with 10 MVA connection power and extreme ground conditions:

- 1) measurement of electric soil resistivity (figure 1)

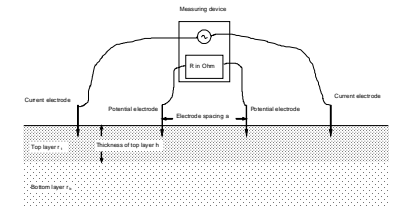


Figure 1: Setup of Wenner method

- 2) data acquisition
- 3) determination of relevant currents
- 4) basic system design, including specifications on materials and required cross sections
- 5) planning and simulation of the grounding system and calculation of surface potentials in critical system areas (figure 2)

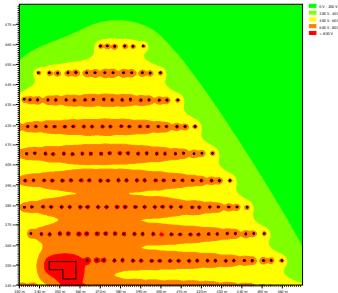


Figure 2: Example of calculated surface potentials

- 6) check of the grounding system by means of the heavy current injection method (figure 3)

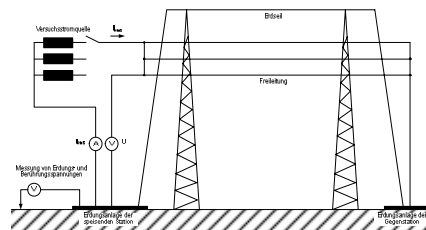


Figure 3: Setup of heavy current injection test

By integrating the concrete encased steel structures demanded by the static conditions with the solar plant and the calculated verification of their grounding effects there was no need for gravelling the solar plant area or integrating a wide-area copper wire grounding system.

Application example 2

This example describes fault clearing after a cable fault at the sealing ends of a high current connection with medium-voltage cables. The sealing ends suffered severe thermal damage (figure 4).



Figure 2: Thermal damage to cables

The tasks are described here:

- 1) discussion of fault event
- 2) site survey and recording of as-is state of grounding and equipotential bonding systems
- 3) analysis of fault event
- 4) calculation of the distribution of currents on the cable shields and the surrounding grounding systems
- 5) discussion of the results and alternative solutions with cable experts
- 6) design of a concept for shielding of medium-voltage cables and grounding measures in the adjacencies of the affected voltage level
- 7) documentation and testing of the implemented solution by means of IR (infrared) camera and measurement of currents in the grounding system components

The development of a clearly structured concept has allowed us to use this approach as a reference for comparable tasks. In this specific project, because of a detailed cause analysis, the costs could partially be claimed by the client.

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