DIgSILENT GmbH
Company Profile

DIgSILENT GmbH is a consulting and software company providing engineering services in the field of electrical power systems for transmission, distribution, generation and industrial plants.

DIgSILENT GmbH was founded in 1985 and is a fully independent, privately owned company located in Gomaringen/Tübingen, Germany, where the new offices have been in operation since early 2002. DIgSILENT continued expansion by establishing offices in Australia, South Africa, Italy, Chile and Spain, thereby facilitating improved service following the world-wide increased use of its products and services. DIgSILENT has established a strong partner network in many countries such as Mexico, Malaysia, UK, Switzerland, Colombia, Brazil, Peru, Argentina, Iran, Venezuela and China. DIgSILENT services and software installations have been conducted in more than 110 countries.

DIgSILENT PowerFactory
DIgSILENT develops the leading integrated power system analysis software PowerFactory, which covers the full range of functionality from standard features to highly sophisticated and advanced applications including wind power, dispersed generation, real-time simulation and performance monitoring for system testing and supervision. For wind power applications, Power Factory has become the power industry's de-facto standard tool, due to PowerFactory models and algorithms providing unmet accuracy and performance.

DIgSILENT StationWare is a reliable central protection settings database and management system for the complete power system substation data based on latest .NET technology. Station-Ware stores and records all settings in a central database, allows modelling of relevant workflow sequences, provides quick access to relay manuals, interfaces with manufacturer specific relay settings software and integrates with PowerFactory software, allowing powerful and easy-to-use settings co-ordination studies.

DIgSILENT Consulting
DIgSILENT GmbH is staffed with experts of various disciplines relevant for performing consulting services, research activities, user training, educational programs and software developments. Highly specialized expertise is available in many fields of electrical engineering applicable to liberalized power markets and to the latest developments in power generation technologies such as wind power and dispersed genertion. DIgSILENT has provided expert consulting services to several prominent wind-grid integration studies.

PowerFactory Monitor is a flexible performance recording and monitoring system that copes easily and efficiently with the special requirements for system test implementation, system performance supervision and the determination and supervision of connection characteristics. Numerous Monitoring Systems installed at various grid locations can be integrated to a Wide-Area-Measurement-System (WAMS). The PowerFactory Monitor fully integrates with the PowerFactory.

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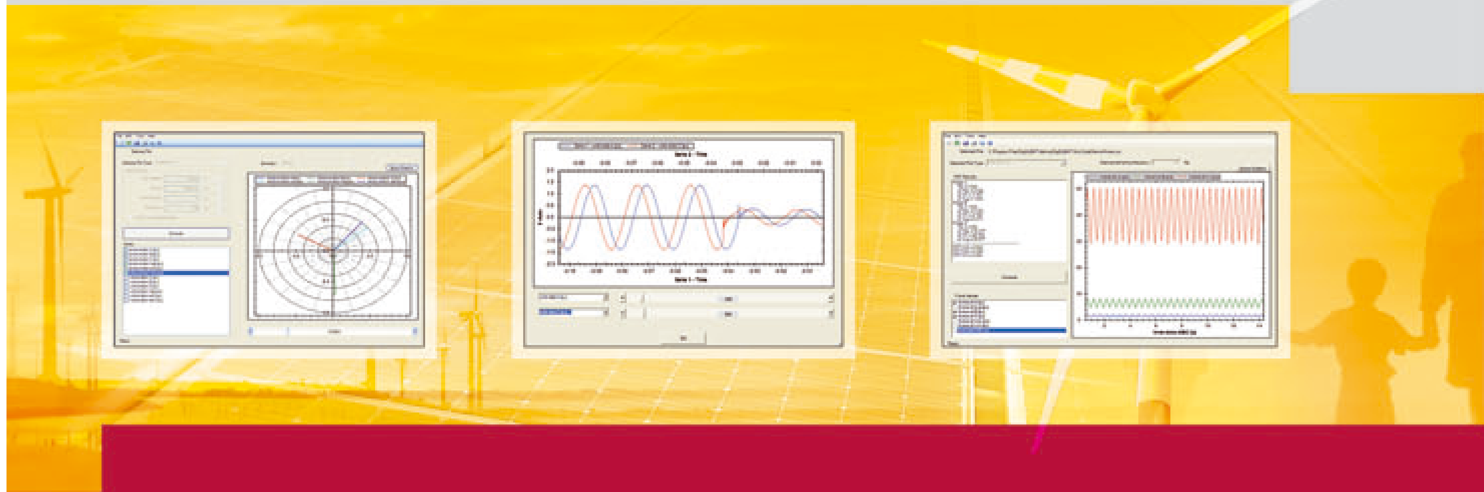
POWER SYSTEM ENGINEERING AND SOFTWARE

PowerFactory

Power System Monitoring and Analysis
The DIgSILENT GridCode



Worldwide Grid Code Assistant

- Most recent Grid Codes available
- Supports development of new Grid Codes
- Country-dependent LVRT analysis
- Input from field measurement or simulations
- Automatic event detection
- Robust algorithms for data post-processing
- On-line or off-line check for compliance
- Fast verification of requirements
- Voltage dip shape inspection
- Active and reactive power support supervision
- Survey of power recovery conditions
- Frequency variations examination
- Model validation
- Accurate synchronization between measured and simulated data
- Special model validation methods
- Easy navigation through result plots
- Automatic reporting

Standard and specific non-standard capabilities

- IEC61000-4-7 for harmonics
- IEC61000-4-15 for flicker
- IEC61400-21 for wind turbines
- Special power quality functions
- Fast resampling available
- Fusion of electrical and mechanical data
- Easy definition of new limits and alarms
- Country-dependent limits verification
- Integrated with PowerFactory
- Automated into SCADA systems

DIgSILENT
GridCode

New rules to connect generators to the grid are emerging worldwide. In every country or region, the operators responsible for the safety and reliability of the power system, have established different requirements to connect renewable generation systems to the electrical networks depending on the particularities of every power system. The term "Grid Code" is frequently used to refer to these rules and laws which define the technical requirements for third parties connected to public electricity systems, i.e. consumers, generators, and other network operators. In some countries, there may be separate documents for different classes of users, such as different generation technologies (e.g. wind) while in some other countries, there are different documents for transmission, distribution and low voltage systems.

Rules and conditions on the desired transient behavior of the power plant against undervoltage, overvoltage, underfrequency and overfrequency events.

Rules and conditions on the allowed power quality impact on the external power system where the plant is connected (harmonic, interharmonic, long term or short term flicker).

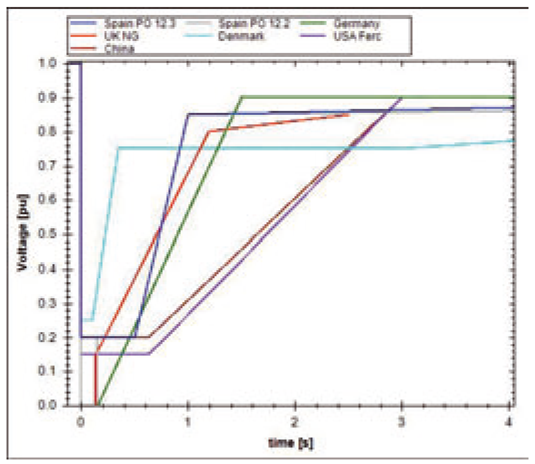
Rules and conditions on the controllability of the power plant (power factor control, reactive power control or complete response to real-time operation PQ setpoints from a dispatch center).

WORLDWIDE GRID CODES: SIMILARITIES AND DIFFERENCES

Historically, Grid Codes have been developed on the basis of the particularities of every country with a common objective and the need of maintaining a high quality, controllability and stability of every power system. The particularities of every nation result in the implementation of non standard and country-specific rules, however some common denominators can be found in worldwide Grid Codes.

The differences in a Grid Code are generally associated not only to the transient stability issues but also to their interpretation. Most of the differences we have found are due to the lack of international standards, which is not the case for power quality concerns as harmonics or flicker. A complete technical standardization concerning transient stability conditions could lead to the implementation of requirements from the most stringent nation, which would not be adequate for the rest of the countries. The following inequalities can be found in Grid Codes from one country to another:

The need of maintaining the stability of the system and the capability of reaching a new steady state after a short circuit in the network, leads to the definition of "Low Voltage Ride Through (LVRT)" rules. Most of the countries are defining requirements on the desired behavior not only during the voltage dip but also during the period of recovery after the event, as for example the voltage support by reactive power injection. Voltage dip shape can significantly differ from country to country, as it can be seen in the figure:



Voltage dip shape in Germany, Spain, UK, Denmark, USA and China

There are differences on the point of the network where the Grid Code rules must apply, either at terminals of a single generation unit or terminals of a whole power plant composed by distributed generation units.

Some differences exist on the verification procedure to check for compliance. The verification in some countries is based on complex procedures including real-life testing and measurements in terminals of a single unit, data post-processing and simulation of the whole power plant. The trend is clearly going towards simulation procedures as power plants are reaching important MW-sizes.

Developers who operate in various countries are facing different measurement techniques and calculation methods. For example, they are faced with the dilemma: which value should we use to verify a dip depth, the instantaneous voltage, the rms or fundamental value or the positive sequence component? Phase to phase or phase to neutral?

The requirements to be fulfilled during and after the voltage dip are different, as for example the requirements of reactive current support and active power recovery. These rules are either based on rated values, or the limit is depending on the reached depth of the voltage dip, depending on the recovery time of the dip, etc.

DIgSILENT
GridCode

DIGSILENT GRID CODE V1.0

DIgSILENT has developed and released a new analysis tool called "DIgSILENT GridCode v1.0", in response to the need of verifying if a wind farm, solar plant, or any other generator is compliant with the local Grid Code requirements. Some of the functions can be verified off-line or on-line.

DIGSILENT GRIDCODE V1.0 KEY FEATURES:

"Data Visualizer" to plot data series and graphs

"Grid Code Compliance" to check the compliance with given requirements. The following Grid Codes are supported:
- Spain: REE P.O 12.3 according to PVVC both particular and general procedure. Draft interpretation of the last updated P.O.12.2.
- Germany: E.On Netz 2006 High and Extra High Voltage
- UK: NGC Grid code
- Denmark: EnergyNet (voltage dip shape)
- IEC 61400-21 Ed 2 (voltage dip shape)

"Model Validation" to check if simulation and test results are matching

"Flickermeter IEC 61000-4-15" to assess flicker emission levels

"Harmonics IEC 61000-4-7" to assess harmonic levels

Toolbox **"IEC 61400-21: Measurement and assessment of power quality characteristics of grid connected wind turbines"** to calculate instantaneous flicker, flicker coefficients, flicker during switching operations, to assess current harmonic emissions, interharmonic and higher frequency component emission levels, observation of the evolution in time of DFT components.

"Phasors Viewer" to plot the evolution in time of spatial phasors (fundamental and sequence components, line and phase measurements)

Extra tools have been developed to improve post-processing to manage files from different measurement equipments and to allow users to create and develop their own grid code:
"GridCode Editor" to edit the requirements of the selected grid code

"File Editor" to post-process data files and speed up the analysis

"Resampling" to resample files to a higher or lower sampling frequency

"File merging" to synchronize and bring together files at different sampling rates (wind speed file + instantaneous voltage-current file)

WHO MAY USE DIGSILENT GRID CODE

DIgSILENT GridCode is currently being used by manufacturers and laboratories to check the compliance during field testing of wind turbines. DIgSILENT GridCode is being used to check for wind farm compliance from Spanish developers.

NETWORK OPERATORS

Power system operators are facing the complexity of laying down fundamental requirements and procedures that govern the operation and development of the electric power system. A Grid Code development may take several years and be reviewed several times. DIgSILENT GridCode can help a network operator in the process of studying Grid Codes in operation in other countries, to create their own Grid Code and to check robustness of new requirements before publishing them. The network operator can also use DIgSILENT GridCode in engine mode, running on-line to verify the behavior of the generators during and after voltage dips and supervision of the power plant non-disconnection, according to the selected grid code or other international standards (Spain-REE, Germany-E.On and MV, England – NGC, France-RTE, IEC-61400-21 Ed.2, others)

RENEWABLE POWER PLANT DEVELOPERS

Developers are facing different connection criteria in different countries. The power plants need to be often adapted from one country to another to be able to fulfill all the requirements. DIgSILENT GridCode can help in example, at the design stage of a wind or solar power plant to define additional investments for compliance and during the whole life of the plant to perform on-line monitoring and supervision of the correct operation of the installation and thus, check for the benefits of the initial investment. In case of disconnection of a wind power plant, DIgSILENT GridCode will generate an alarm and an analysis of the event, allowing the developer from its office desk, to verify in which conditions the plant was disconnected.

MANUFACTURERS

In designing, building and operating its products, the renewable and classical power industry has to consider a variety of Grid Codes with different technical requirements. These aspects are causing efforts from the renewable power industry to develop hardware and software solutions to comply with different worldwide conditions. DIgSILENT GridCode can be used during the design step by the design department to check with simulation results if the product will fulfill the requirements in every market. Moreover, once the prototype is installed, the testing department can perform the needed tests to check for compliance with DIgSILENT GridCode. The independent analysis and final approval of results given by DIgSILENT GridCode is the final task of every department.

LABORATORIES AND CERTIFICATION BODIES

Network operators or governments may have defined in their Grid Codes or Laws the need of accreditation or certification procedures. In countries where the product needs to be tested by an accredited laboratory and/or certified by a certification body, DIgSILENT GridCode can be used by both independent bodies to post process field measurements and simulation results, compare them for model validation, etc. The software can be used to be validated in international round robins where the laboratories may participate to prove their accreditation every year or 2 years. The independent analysis and final approval of results given by DIgSILENT GridCode is the final task of laboratories and certification bodies.