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Experience with Measurement and Certification of the Over Voltage Capability of Wind Turbines after Introduction of the New High Voltage Grid Code VDE 4120

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Introduction

Overvoltage events can be caused by one or two phase faults in transmission lines. Other overvoltages can result from a transient change in the load of a transmission line, where the capacitive behavior abruptly becomes dominant (Ferranti effect).
This critical grid situation is not unknown to wind turbine manufacturers. Designing a wind turbine to stay online - as required by more and more grid codes - is very costly, considering that such grid situations are rather rare. If grid operators opted for a more stable system, they have to demand as well the OVRT (Over-Voltage-Ride-Through) capability. In order to ensure a fair market competition amongst manufacturers, test and certification procedures of the technical requirements should be defined clearly and be standardized. Experiences from the application of the new German technical test, validation and certification guidelines (FGW TR3, TR4, TR8) will be shared.

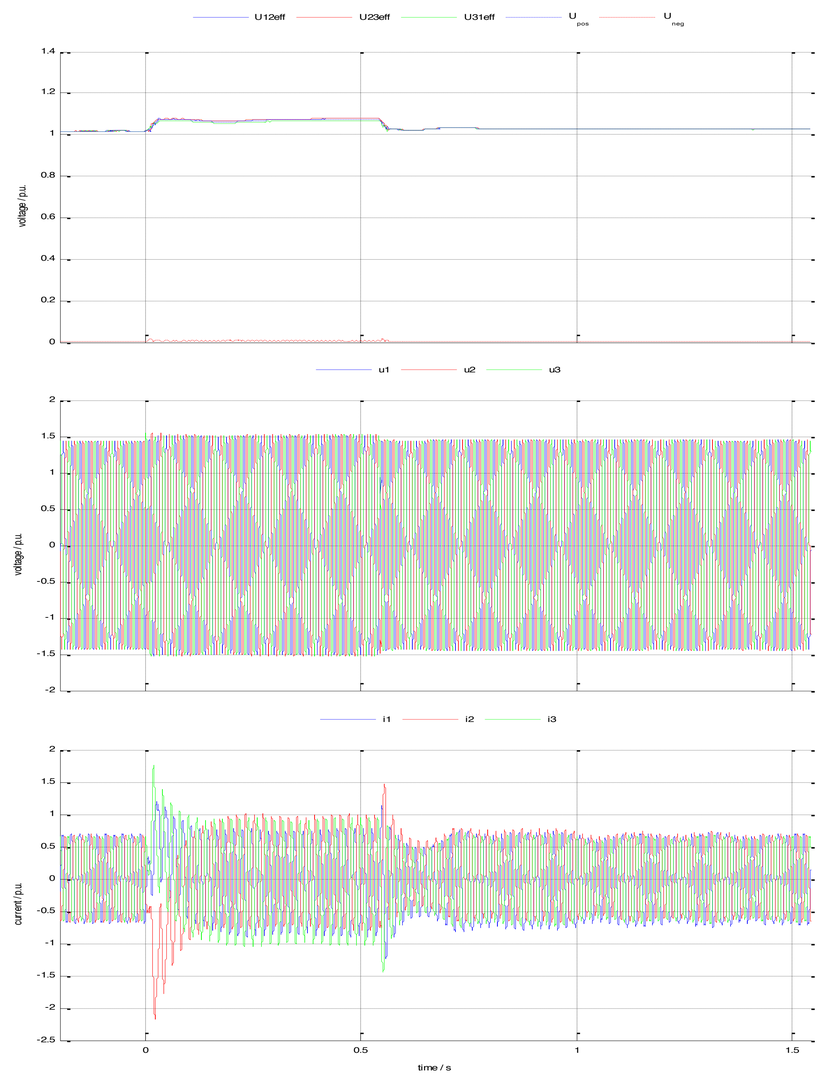
Approach

Grid Code Conformity Process	International	Germany	Sub-working Groups of FGW were WGC is Active Member additionally to the TR3, TR4 and TR8
Measurement of Control, Protection, Reactive Power Capability and Quality Values	IEC 61400-21	FGW TR3	Harmonics, Protection, Specific to type 1 machines (SG) Test rig
Measurement of FRT Values	IEC 61400-21	FGW TR3	Type 1 machines (SG) Test rig
Unit Model Validation of FRT Values	IEC 61400-27	FGW TR4	Grid studies
Plausibility Check of Manufacturer's Declaration	n/a	FGW TR8 Result is a unit certificate	Unification of certification results
Surveillance of Power Generating Unit	n/a	FGW TR8	Unification of certification results
Specific Model Validation of Power Generating Plant	IEC 61400-27	FGW TR4 and FGW TR8	FRT in power plant
Plausibility Check of Project Developer	n/a	FGW TR8 Result is a unit certificate	Unification of certification results
Surveillance of Power Generating Unit	n/a	FGW TR8 Result is a conformity declaration of certification body after commissioning of power plant	Unification of certification results

Standardization of Grid Code, Conformity Check, IEC Guideline, German Technical Rules (TR) and Sub-working Groups

WindGuard Certification (WGC) is member of the working groups of the FGW and significantly involved in the development of standardized test and measurement procedures related to the certification of overvoltage capability. In Germany, the different steps are described in to 3 separate guidelines. The FGW TR3 describes the measurement procedures adapted to the German market, in the same way, the IEC 61400-21-1 aims for the international market.
The FGW TR4 describes the wind turbine computer model validation. The FGW TR8 is divided in two sections, the first section covering the type certification of single power generating units and the second, describing the certification of power generating plants. In Germany it is mandatory that these power generating plant certifications are based on certified power units.
New versions of all three guidelines were published on 1st of March 2016. Next revisions of these guidelines are expected at the end of the present year.

Measurement results of an OVRT test performed on PGU:



The FGW TR3 (measurement guideline) was adapted to the new requirements of the new grid code for high voltage connection VDE 4120 (mainly 110 kV). A new revision of FGW TR3 is expected to be issued close to the announced new grid code VDE 4115 for medium voltage connection (mainly 7,5 kV until 35 kV).
The FGW TR4 (model validation guideline) has been approximated to the IEC 61400-27, however, this guideline has to consider the special requirements of the new grid code.
The results of an electrical wind turbine capability evaluation according to TR3 and TR4 will be joined together in the unit or type certificate according to FGW TR8. The plant certification section of the FGW TR8 provides standardized rules for the assessment of wind farms. .

Conclusions

With the additions in the new FGW guidelines, it is now possible to approach the subject OVRT utilizing standardized procedures. Starting from the measurements of the behavior of the wind turbine during overvoltage, up to the corresponding adjustments in the model validation TR4 and integration in the unit or type certificates, it is now possible to individually forecast the behavior of an overall wind farm.

References

/FGW TR3/ Technical Guidelines for Generator Units of the FGW, Part 3: Determining the Electrical Properties of Generator Units at Medium-, High- and Extra-High-Voltage. 2016-03-01

/FGW TR4/ Technical Guidelines for Generator Units of the FGW, Part 4: Requirements to Modelling and Validation of Simulation Tools of the Electrical Behaviour of generation units and power plants. 2016-03-01

/FGW TR8/ Technical Guidelines for Generator Units of the FGW, Part 8: Certification of Generator Units and Generation Plants at Medium-, High- and Extra-High-Voltage Grids, 2016-03-01

/IEC 61400-21-1/ Wind turbines- Part 21-1: Measurement and assessment of power quality characteristics - wind turbines" Committee Draft (CD). Date of circulation 2014-07-11

/ IEC 61400-27-1/ Wind turbine generator systems – Part 27/FDIS Draft: Electrical simulation modules – Wind turbines 2014-10-31

/VDE-AR-N 4120/ Technical requirements for the connection and operation of customer installations to the high voltage network (TAB high voltage), 2015-01-01