

Voltage control with microturbine

CHALLENGE

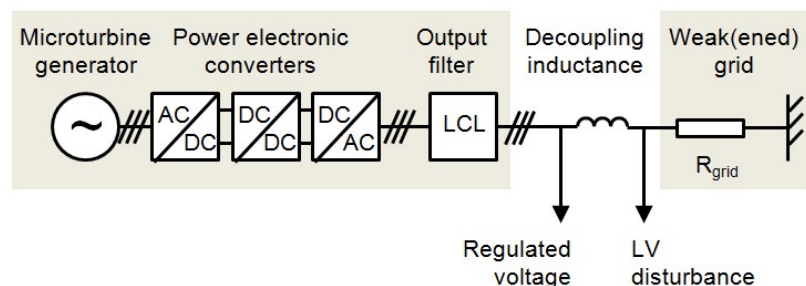
The active power from DG units affect voltage, which is one of the factors limiting the amount of DG. While reactive output of large power plants is used to control voltage, it is normally required to be zero for DG units. The very small rated power of DG units and the resistive character of low voltage cables also strongly limit the impact of reactive power on voltage at LV level. Can a DG unit really control voltage?

SOLUTION

Connecting the unit through a series inductance gives a connection point at the microturbine terminals where voltage can be regulated. This provides improved voltage quality for loads of limited rating. The solution effectively rejects both voltage dips caused by switching of local loads and disturbances originating in the feeding network. Network strength and impedance character are not critical.

PROTOTYPE

In the ADINE project, a Com-power microturbine prototype rated 5 kW_e has been equipped for voltage control. The commercial single-phase power electronic converter is replaced by a three-phase prototype connected to the network through 7 mH inductances. The converter is controlled using a standard vector control scheme with a voltage controller setpoint equal to nominal network voltage.



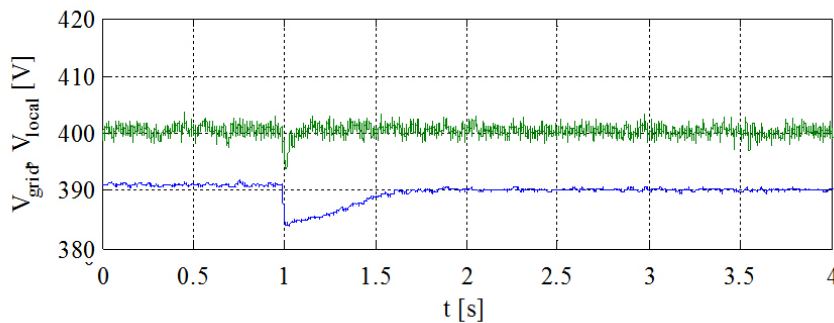
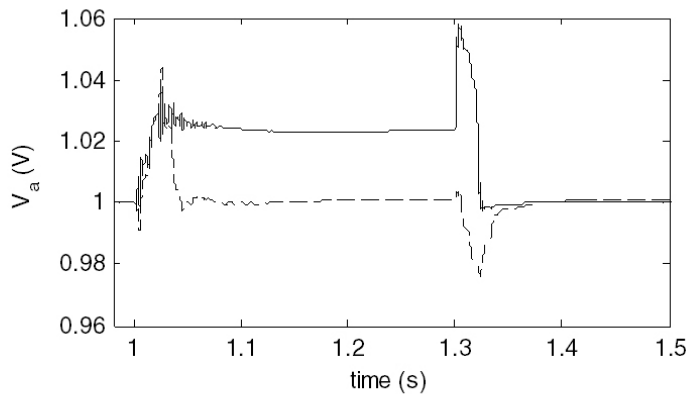
Compower microturbine prototype (left) at field test site with converter to be replaced (red box). Connection to LV network through decoupling inductance (right).

SIMULATIONS

The power electronic converter of the microturbine has been modeled in Matlab and in RTDS/dSPACE together with its controllers. The simulated events include disturbances originating both on the LV and MV levels. Examples of the former are starting of motors in the low voltage network, while capacitor switching belongs to the latter type. The simulations indicate that the control scheme eliminates steady state voltage deviations. Also at transients voltage deviations are efficiently reduced.

FIELD TEST

The microturbine field test site in Kristianstad has easy access to biogas, but has a very strong network connection point. To emulate a more remote site, 100 m of low voltage cable is inserted which yields a weaker connection point. This resistance has also been included in the simulation model. Starting of a 2 kW motor on the weak side of the added resistance causes a clear voltage dip. As shown below this is well suppressed at the protected point, which indicates that the control scheme is both feasible and efficient.



Voltage on converter side (nearest 1 p.u. and 400 V) and grid side of the decoupling inductance. Simulated response to switching of 2,5 Mvar shunt capacitor at MV level (top). Measured response to direct starting of 2 kW three-phase asynchronous motor (bottom).



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