BACK

IN DEPTH

A STATCOM that helps wind to meet grid codes

Comply with tighter rules *08/10/2014 - 5.41 pm*

POWER QUALITY   SVC – STATCOM   WIND

A suitable STATCOM can be used to ensure that wind turbines comply with increasingly tight grid codes, particularly the low voltage ride-through requirement. It also needs to be compact and flexible.

Post a comment

Over the last 20 years, wind power has asserted itself as an increasingly important part of the energy production landscape. The 2011 World Wind Energy Report projected that by the end of that year, total capacity would be around 245,000 MW and meet 3 % of global electricity demand. Since then, the Global Wind Energy Council states that by 2020, 8-12 % of global electricity could be supplied by wind power.

The rise of wind power has emerged as a challenge to the technology used to generate it and, as more and more renewable energies flow into the grid, grid operators have grown concerned about stability. Accordingly, they are introducing ever more stringent grid codes to ensure that grids can integrate renewable energy smoothly. Not all wind turbine technologies can comply with such demanding strictures, however. One that cannot on its own is the doubly fed induction generator (DFIG). Until recently, DFIGs were the most widely used variable-speed wind turbines. A DFIG's stator is directly connected to the grid while the rotor is connected through a power electronic converter, which controls the generator's speed and power factor. The converter is rated at around 30 % of the turbine's nominal capacity, which was ample for wind turbine applications until grid codes required turbines to stay connected to the network during voltage drops to ensure low voltage ride-through

(LVRT).The drawback of DFIGs is that, in the event of a voltage dip, the voltage of the grid connected stator changes suddenly.

« In the event of a sudden load change or low voltage incident like a short circuit in the grid, a STATCOM responds fast. »

The rotor voltage is too low to compensate and so a disturbance current flows through the stator and rotor, damaging the converter. The DFIG's original control strategy was to trip, but grid codes now require generators to ride through voltage drops and feed reactive power into the network to stabilise it. The only alternative is to enlist the support of a shunt-connected dynamic reactive power source. The most widely used is the thyristor-based static VAr compensator (SVC). But SVCs do not fit the requirements for (i) fast dynamic response, (ii) short overload capability, or (iii) the ability to provide maximum reactive output current during sharp voltage drops. However, one dynamic reactive-power compensator that does deliver on all three counts, and so ensures ride-through in the event of a network fault, is the static synchronous compensator, or STATCOM.

1__How STATCOMS ensure ride-through

"In the event of a sudden load change or low voltage incident like a short circuit in the grid, a STATCOM responds fast," explains Ralf Jessler, Managing Director of the Alstom unit in Konstanz, Germany. It feeds capacitive reactive power into the network, increasing voltage at the point of common coupling (PCC), so helping the DFIG to stay connected for as long as it takes to isolate the short circuit. Once the fault has been cleared, however, the DFIG may experience the same kind of difficulties as it did when the fault occurred. The STATCOM must therefore once again stabilise the voltage at the PCC. “This is no issue,” adds Jessler, “because the STATCOM responds dynamically, in milliseconds, changing its reactive power from capacitive to inductive.”

In sum, then, a STATCOM ensures low voltage ride-through because it can continue to generate rated output or short time overload current even at low system voltages. Low voltage ride-through is doubtless the most important capability required of a STATCOM, as illustrated by a wind farm project in Dunneil, Ireland, where the turbines were augmented by Alstom’s novel STATCOM, SVC MaxSine™. Without it, the generators would have fallen short of the local grid code for LRVT as they failed to produce enough reactive power to compensate the steep voltage drops. To help a DFIG ride through a fault event, overload capability is crucial. “Most STATCOMS are installed for voltage drops caused by short circuits, which seldom happens,” explains Jessler. “So we tailored MaxSine™ to deliver high overload for the 10 or 20 seconds it takes to isolate the short circuit. That way, we were able to make it smaller.” What’s more, an effective overload capability helps reduce the STATCOM’s installed power capability, which reduces its cost.

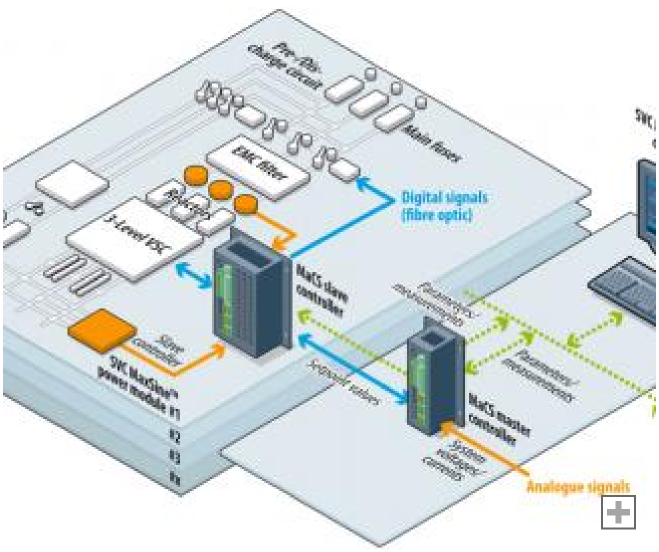
« We tailored MaxSine™ to deliver high overload for the 10 or 20 seconds it takes to isolate the short circuit. »

Hybrid compensator keeps prices and flicker low
Brief dips in line voltage, causing, for instance, brief changes in lighting levels, are known as "flickers" and are a sign of poor power quality. They are typically caused by large loads whose active and reactive power demand fluctuates. The technology of choice for reducing flicker is the static VAr compensator (SVC). SVCs are traditionally used for reactive power compensation in such heavy industry applications as electric arc furnaces (EAF). However, the thyristors controlling the reactive power do not have enough bandwidth (i.e. they cannot respond quickly enough) to respond to fast changes in the load. The result is as much as a half-cycle time delay. Consequently, an SVC has at best a flicker mitigation capability of just 65 % and a flicker reduction factor of 2, which is often inadequate. These figures stand in contrast to those of VSC-based STATCOMs, which continuously control the output current and thus compensate load changes immediately. STATCOMS can achieve a flicker reduction factor of 6, while SVCs are more cost-effective when compensation power is high (above 20 MVAr). The ideal solution would appear to be an SVC-STATCOM hybrid. Alstom R&D teams have developed a concept known as "Hybrid SVC" that they have tested with an electric arc furnace. The result is a highly reliable compensation system with a flicker reduction performance that is almost as good as a STATCOM's. It is 20 % cheaper to install than a STATCOM and costs 50 % less to operate.

2__Low losses, small size, high flexibility

At the heart of the SVC MaxSine™ is a voltage source converter with a three-level neutral-point clamped topology (3L-NPCVSC) and a patented control system. The main advantage of the 3L-NPC-VSC is that it enables commutation at low voltages. It also improves the harmonics spectrum and increases the quality and quantity of output voltage, thereby reducing the flicker level significantly in the network. The patented control system is what enables SVC MaxSine™ to respond to sudden network changes or resetting in a matter of milliseconds. It is key to the compensator's prime function – ensuring the generator's LVRT capability. Second only to ride-through in wind power applications is the importance of controlling power losses. SVC MaxSine™ considerably reduces transmission line and reactive power losses, thus offsetting losses that may occur through frequent switching of the converter.

« Should one module malfunction or fail, other units continue to operate, so avoiding downtime. »



Also, because it is a medium voltage system, it requires fewer power electronic devices to be switched on than low voltage compensators, whose multiple devices must all pass current and therefore generate losses. Flexibility is a key feature of the SVC MaxSine™ STATCOM solution. Unlike conventional SVCs, which have to be re-dimensioned according to the prevailing network impedance and harmonics, the SVC MaxSine™ interoperates with existing network equipment and works with it to deliver compensation performance more effectively than a conventional STATCOM. Also its control system can be reconfigured to meet applications ranging from wind farms to power-hungry arc furnaces. With its compact, modular power electronics units housed in a container, SVC MaxSine™ can be configured to meet varying needs. The modular design then contributes to its high operational availability. The power electronic modules (each sealed in a steel container) are arranged in parallel, each acting as an amplifier and feeding current into the network.

It is a simple matter to add or remove them according to requirements. And should one module malfunction or fail, other units continue to operate, so avoiding downtime

RATE THIS ARTICLE

COMMENTS

SIGN UP FOR OUR NEWSLETTER

LEARN MORE

EXPERTS

Jarmo Aho
R&D Engineer

Ralf Jessler

Managing Director of the Alstom unit in Konstanz, Germany

SEND A MESSAGE TO OUR EXPERTS