Higher availability of power stations with fault-tolerant fiber optic networks - Optical bypass in wind farms
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Optical bypass in wind farms

Power stations have very high standards of reliability and availability. This is particularly the case for wind farms located over vast areas and often difficult to access. Modern, fiber optic based controllers for these installations have to take this into consideration and have to be designed fault-tolerant.

Every wind farm operator’s nightmare: A fault in a turbine cuts-off larger parts of the whole wind farm and the weather is too bad to send out a service technician. Especially in locations that are not readily accessible, such as offshore installations, reliability and availability requirements place high demands on design and implementation. This not only affects the energy production itself, but also monitoring and control of the installations. So optical fibers are often chosen for data network, as optical fibers count among the most reliable transmission media of all. Immune against interference and electromagnetic disturbances, they transmit the highest data rates dependably over many kilometers.

To raise fail-safe performance still further, a ring cabling topology has become common in critical environments. Even if the ring is interrupts at one point, all the devices are still connected with one another. But the presumed increase in security can be deceptive. If more than one network node goes down - whether due to a software problem, hardware fault, mechanical damage or a power cut - then the ring topology cannot help either. The entire network between the two failed nodes is no longer accessible.

For a truly fault-tolerant system, the cable runs, lines, feeds to the network nodes and the network nodes themselves would have to be installed in a 2*(N+1) configuration. Everything has to be installed twice and every sub-system has to have one component more than is directly needed for operation. Then there are uninterruptible power supplies and buffer batteries, also doubled and with one additional assembly! Alongside the initial costs for installing such a system, there would be the even higher operating costs and the enormous expense of administration. A scenario of this kind is hardly financially feasible.
Risk management reveals possible entry points

Studies show that downstream areas being cut-off is far more critical that failure of the network node itself. A failed node and the turbine connected to it can often be coped with successfully. It is a different story if entire parts of a wind farm are cut off from communication: Here the question is: How much does a failure cost? How long can one manage without the area cut off? And how much could a company save if it succeeded in bridging failed parts of the installation with simple technical solutions such that the remainder could continue working unimpaired until the defective turbine can be repaired?

The same applies for downtimes due to planned servicing work. The costs are immense if larger areas of a wind farm have to be shut down for servicing. It has to be possible to shut down the turbines to be serviced individually.

A simple, technically versatile solution that simply bridges the failed turbine and leaves the network - including all downstream areas - functional would be a worthwhile investment.

Bypass protects against failure

An optical bypass solves this problem reliably and economically. If a network node goes down, the bypass bridges it automatically and maintains communication beyond the failed node point.

The Fiber Protection Switch from Microsens makes the optical network fault-tolerant and offers the power station operator a significantly higher network availability. Even if individual network nodes fail, all other sub-areas are still accessible. The failure is restricted to the failed network node.

The bypass can be triggered manually for servicing work. Network nodes no longer need to be shut down in a time-consuming way - the bypass separates the node to be serviced from the grid during ongoing operation and thus allows uninterrupted repair and servicing of the wind farm. As a result of the correspondingly lower servicing costs, this solution soon pays off.

Several turbines can also be serviced or replaced at the same time during ongoing operation of the park, because the remaining turbines and network areas are not affected by the work.

A simple alarm relay can also be used to control external alarms, which considerably simplifies the automatic alarm and reduces administrative costs which leads to lower operating costs.

Application for rail mounting: The optical bypass Fiber Protection Switch (right) protects the switch with power supply (middle and left).
The bypass concept has proven itself in practice. The first offshore wind farms have already been equipped with the Fiber Protection Switch from Microsens. One of these farms consists of a hundred individual wind turbines in groups of ten. Each of this group is connected to the central switch via an optical fiber ring.

If a network node in a group with conventional cabling without a bypass were to go down, the remaining nine turbines would continue to be up and running. Should a second node fail, all the wind power turbines between the two failed nodes were no longer accessible and would have to be automatically shut down. The resulting loss per day would be considerable, because electricity supply contracts prescribe high penalty payments in the event of non-delivery. A service team would have to arrive on-site at short notice and fix the problem as quickly as possible. In the case of wind farms in the North Sea, the weather may well be too bad for days - sometimes up to three weeks - to reach the wind farm by ship or helicopter. The loss caused by a failure of this kind would be immense!

This is why the wind farm operator decided to install the Fiber Protection Switch, the optical bypass from Microsens. The bypass bridges the failed network node within a short time, all other turbines remain accessible and can continue working unimpaired. If the optical bypass only once ensures that the remaining turbines stay accessible, the investment for the whole wind farm has already more than paid off.

Another advantage: As each wind power turbine has its own optical bypass, several maintenance teams can service different turbines at the same time without the others being impaired, which significantly drops the servicing costs.

The bypass concept is, of course, also suitable for onshore installations that are often in remote rural areas.

The use of the Fiber Protection Switch secures the fiber network even in case of multiple failures.

While using the Fiber Protection Switch in a bus topology all network nodes behind the point of failure are still accessible.
Reliability through robust design

An optical bypass should obviously not itself be a source of error. Therefore, it has to be designed as simple and robust as possible. Practical design means no programming, no configuration and no firmware for which updates have to be installed or which can lead to a system crash. Refraining from complex semiconductor technology makes the bypass extremely robust. In normal operation it works as a „normally closed“ switch. If the network node which the bypass should protect is running, then the Fiber Protection Switch works in the „open“ state and all data flow through the network node. Should the network node fail or the power supply break down here, the switch is automatically „closed“ and bridges the failed node. Vendor-neutral and without configuration. And its high temperature resistance and robust design makes it suitable for the toughest environmental conditions.

Conclusion

An optical bypass can allow wind farm operators to profit from a significant boost to their failsafe performance and economic efficiency. The robust design without complex semiconductors and firmware offers a hitherto unattained level of reliability even under extremely harsh conditions. Especially for remote and hard-to-access installations, the investment in an automatic bypass pays off within a short time.

Further information about Fiber Protection Switch: www.microsens.com/fps