



Case Study

NR's Mobile STATCOM

Saudi Arabian National Grid Mobile STATCOM for mitigation of voltage stability and FIDVR (fault induced delayed voltage recovery)

Project Overview

A new era in grid optimization

NR Mobile STATCOM was put into service in Layla and Summan Area of Saudi Arabian on 2 June, 2018. It is the world first energized fully mobile STATCOM.

The STATCOM is rated with 20 Mvar and direct connection voltage is 13.8 kV.



Voltage stability or delayed voltage recovery event is becoming popular in the network with a lot of inductive motor loads such as air conditioner. A Fault Induced Delayed Voltage Recovery (FIDVR) is the phenomenon whereby system voltage remains at significantly reduced levels for several seconds after a transmission, sub-transmission, or distribution fault has been cleared. The low voltage level can result in significant load loss due to motor protective device action. A severe event can result in fast voltage collapse.

Distribution STATCOM is the optimal solution for mitigation of such FIDVR event especially when the STATCOM is located close to the induction motor load.

The STATCOM can quickly inject reactive power and support voltage recovery during and after network fault.

The challenge

One step ahead

It is decided to use fully Mobile STATCOM at two locations which suffer from voltage stability and FIDVR issue.

To ensure flexibility and relocation capability, fully Mobile STATCOM is adopted, which pose great challenge on design due to the harsh operating environment such as very high temperature, sand storm, etc.

The cooling system has to be carefully designed to accommodate such operating conditions. Since all the primary equipment is put inside the container, the container also needs to be specially designed to avoid overheating inside container.

The two Mobile STATCOMs is in good service since June, 2018. It is anticipated that in the future more Mobile STATCOMs will be allocated in distribution network to solve the inherent voltage stability issue with large amount of induction motor operation.

To ensure high availability, redundancy of STATCOM converter sub-modules and cooling system has been optimized to achieve a reliable and cost-effective design

“Mobile STATCOM is VSC-based topology with the feature of modular design and compact footprint, low harmonic, easy for relocation. It will have more and more application for solving voltage stability and FIDVR issue.”

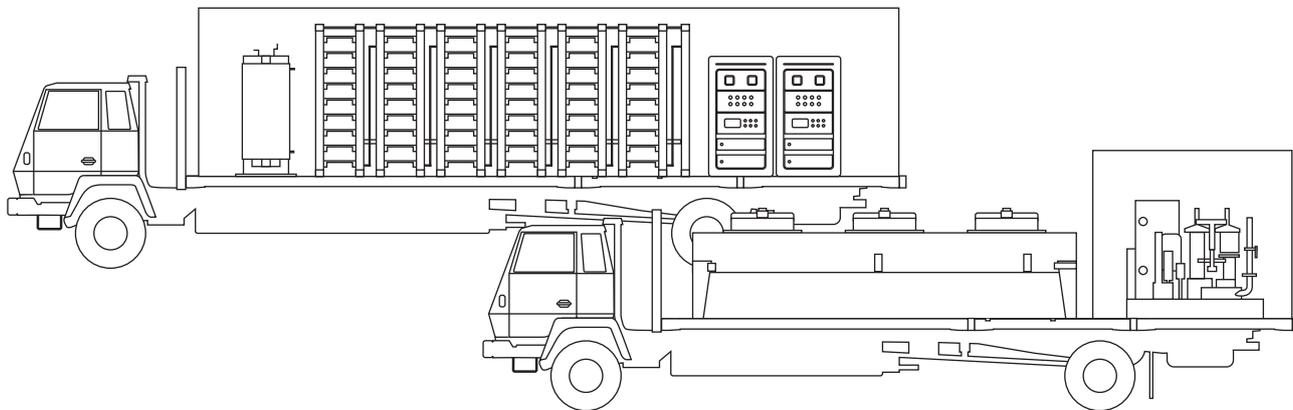
Victor Zhang
Senior HVDC&FACTS Product Manager
NR Electric

The solution

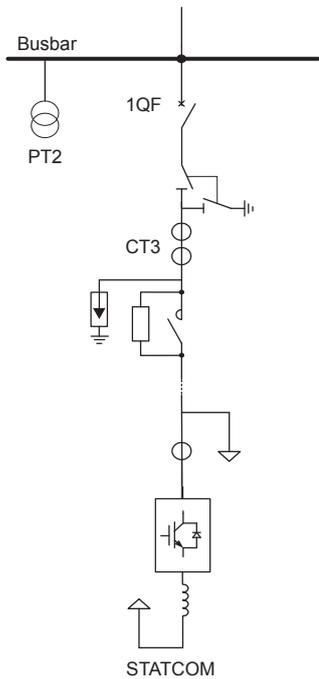
Milestones

STATCOM is the trendy member of NR' s FACTs family of products, an IGBT-based VSC (Voltage Source Converter) installed to assist power grids handle a variety of challenges.

The STATCOM comprises phase reactor, delta-connected IGBT converters, water/air cooling system, controller and protection units, operation work station as well as other necessary accessories.



Layout of Mobile STATCOM



SLD for STATCOM

For transient events such as network fault, the STATCOM will immediately inject reactive power to the system and support the voltage recovery after fault clearing. The STATCOM is also designed to operate even when the system voltage is down to 0.3 pu.

2 regulation modes included voltage control and constant reactive power control, are configured in the STATCOM to satisfy the operating requirements.

In voltage control mode, the STATCOM will automatically regulate the system voltage based on the measured system voltage and the controller setting such as reference voltage, slope, etc.

In reactive power control mode, the STATCOM will generate/absorb required reactive power as set by system operator. Field -test waveforms demonstrate the installed STATCOM is able to spend no more than 30 milliseconds finalizing a step change of reactive power as its important inherent feature.

Excellent Feedback

Mobile STATCOM installed in this project has been playing unique functions to mitigate the voltage stability and delayed voltage recovery issue by fast injection of reactive power to the network. The mobile STATCOM provides more flexibility for system operator. In addition the STATCOM system is also particularly suitable for renewable energy access to power grid. It takes small footprint, less & easy maintenance and has been becoming leading-technology solution for reactive power and voltage support.

“NR’s Mobile STATCOM provides strong voltage and reactive support for distribution and transmission network, which will give system operator more flexibility for network operation.”

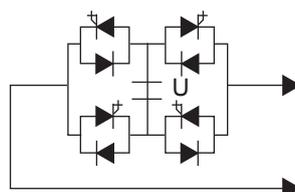
Xiaodong Sheng
R&D Engineer
NR Electric

NR’s STATCOM Features

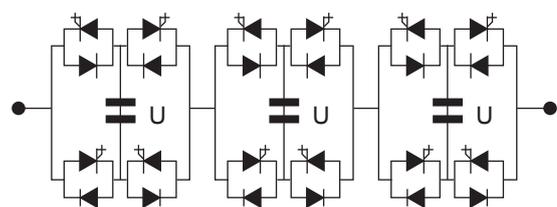
NR’s STATCOM has a simple topology and high degree of prefabrication and in-factory testing, as well as a small footprint to perfectly enable customized solution.

H-Bridge Modular Converter

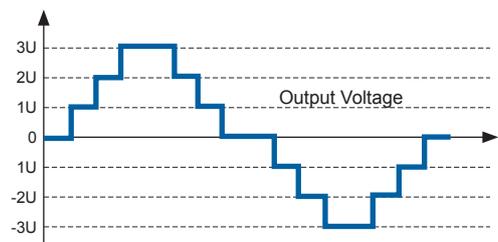
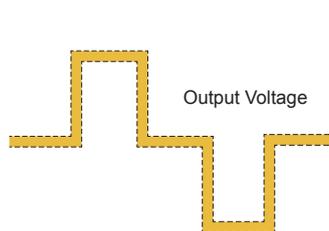
- Compact structure
- Convenient maintenance
- Chain-link multi-level topology
- Perfect sinusoidal voltage output
- Low switching frequency
- Built-in redundant sub-modules in series
- Leading technology in DC voltage balancing
- Well-proven drive and sub control board



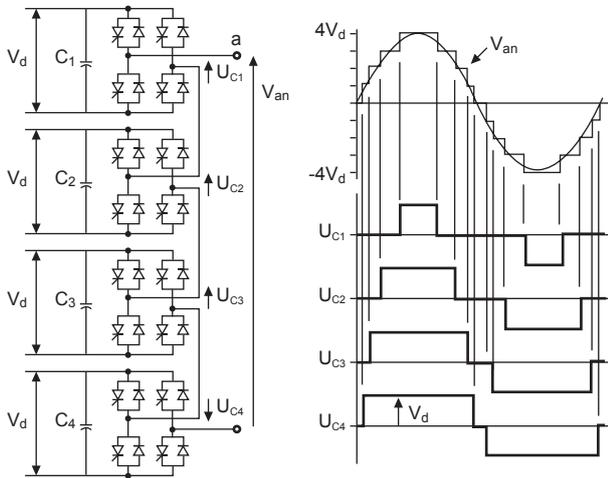
STATCOM sub-module



STATCOM cascading branch



Single phase cascaded H-bridge Circuit



Multi-level output of cascaded H-bridge Circuit

Solution Benefits

Field adaptability

- Small footprint and compact
- Fast reactive power regulation
- Strong low voltage ride-through capability
- Full reactive current output even at depressed system voltage
- Advanced integrated functions with high performance
- Robust control algorithm for voltage and reactive support
- High degree of prefabrication to reduce project lead-time
- Redundant sub-module design for high reliability

Control and Protection

NR's UAPC is a committed hardware platform for control and protection, and field-proven in lots of power electronic product application for decades.

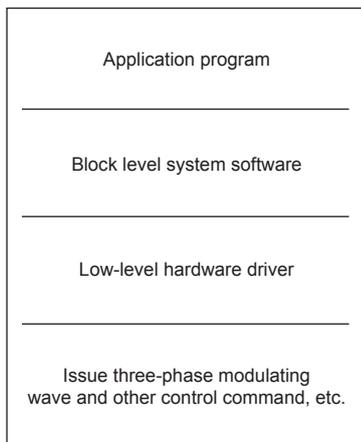
Hierarchical structure is adopted in control and protection system, which consists of primary control and protection system (PCP), valve-based control and protection system (VBC) and sub control and protection unit (SMC). Meanwhile, there are three levels - system level, unit level and device level, to control and protect STATCOM system.

Fiber optical cables are employed to ensure safe control and feedback of the high-voltage bridges. UAPC also includes a whole family of I/O circuit boards for sampling and signal processing. An operator workstation is able to provide various kinds of communication protocol to exchange information and data with substation control system/remote dispatch center.

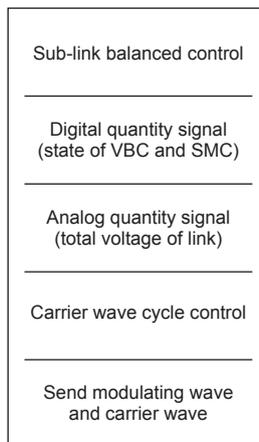


STATCOM HMI

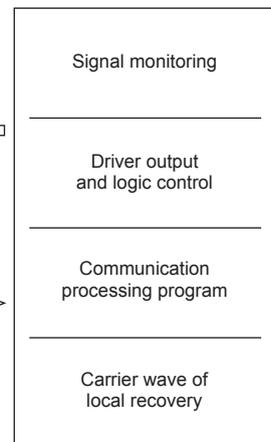
PCP



VBC



SMC



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