



# PASS steps up

ABB hybrid switchgear technology  
is now available for 420 kV

ALBERTO ZULATI – ABB's trademarked Plug and Switch System (PASS) is a high-voltage hybrid switchgear that is preassembled, pretested and easy to transport. With no high-voltage testing required on-site, installation and commissioning is rapid. ABB recently stepped up the voltage level of PASS and it is now available for 72.5 kV to 420 kV applications.



With a PASS installed base of more than 8,000 units, in 2013 ABB announced the launch of the 420 kV high-voltage hybrid switchgear PASS MOS 420 kV.

For many, the world of high-voltage equipment has always been divided between air-insulated switchgear (AIS) and gas-insulated switchgear (GIS). Previously, space requirements usually predicated which option was chosen – with GIS allowing a far more compact, though more expensive, substation footprint. Stated simplistically: AIS was the preferred choice in rural areas while GIS was usually chosen in urban settings. This picture changed dramatically some 20 years ago when ABB introduced PASS.

#### PASS

PASS combines the best of the AIS and GIS worlds into hybrid technology switchgear, or, as it is termed by CIGRE,

combines a lot of advantages of AIS and GIS and leads to a good compromise” [1]. In a case study, CIGRE concluded that “... substantial savings in total ownership

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costs, even when basic equipment costs are higher, could be achieved by adopting MTS equipment. The savings produced are directly linked to land cost. Overall construction times are also reduced. These conclusions were veri-

fied by a pilot project for the construction of three substations in suburban areas. Unanticipated benefits included easier permitting due to the reduced visual impact of the substation and less complicated negotiations with land owners due to the lower land take required” [2].

mixed technology switchgear (MTS). Even if basic equipment costs are higher than AIS, MTS delivers a lower cost of ownership – usually related to lower land costs and shorter construction times. CIGRE states, “... the comparison of technologies indicates that MTS com-

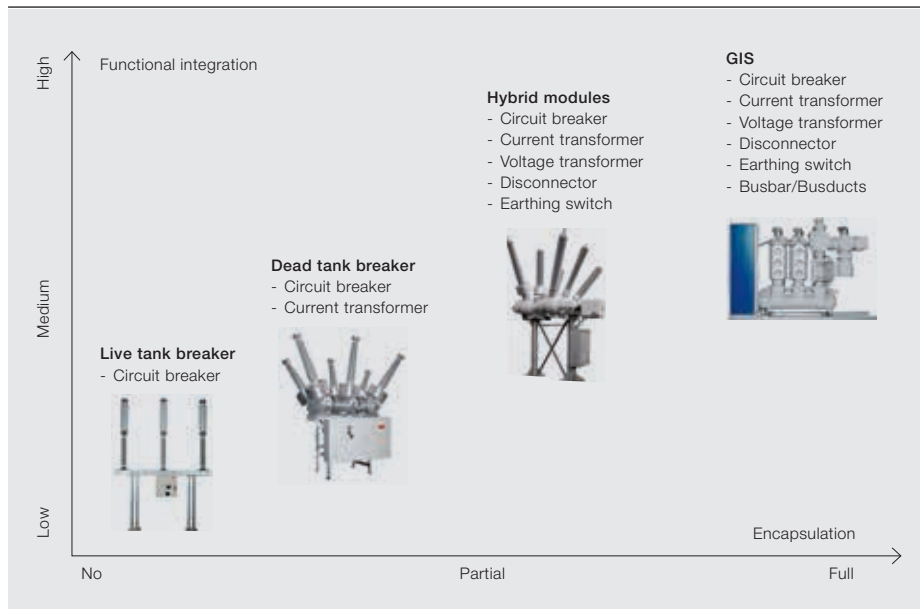
ified by a pilot project for the construction of three substations in suburban areas. Unanticipated benefits included easier permitting due to the reduced visual impact of the substation and less complicated negotiations with land owners due to the lower land take required” [2].

#### Title picture

ABB's PASS switchgear combines the best features of air-insulated and gas-insulated switchgear into a hybrid product. PASS technology is now available for applications up to 420 kV.

The 420 kV PASS hybrid module is a technical breakthrough as, despite its larger size, it retains all of the PASS family benefits, so that each PASS module is equivalent to a complete switch-gear bay.

### 1 MTS technology fits in between AIS and GIS



PASS adopts GIS for the main interrupting components of the circuit breaker and the disconnecter/earthing switch, thus guaranteeing high reliability and compactness. At the same time, PASS uses AIS to connect to the grid, thus positioning itself between AIS technology and GIS technology → 1.

The PASS concept provides a reliable, low-maintenance solution to substation construction. Its modular and flexible design makes it a recommended solution in a number of cases:

- Where space is a constraint, as it allows a 50 to 70 percent space saving when compared with a standard AIS substation.

- In harsh climatic conditions, or in heavily polluted sites like industrial or mining installations. PASS is very suited to these conditions as all live parts are SF<sub>6</sub>-insulated and protected in a grounded aluminum tank. PASS already has a substantial number of such reference installations.

- Fast-track projects where a quick connection to the grid is required – eg, in emergency recovery situations, or in remote or dangerous areas. PASS is transported fully assembled and tested so no high-voltage test is required on-site and installation and commissioning is rapid.

- For railways, because single-phase or double-phase modules at various

frequencies can be used. Over 200 modules are currently in service in frequency converters or traction substations.

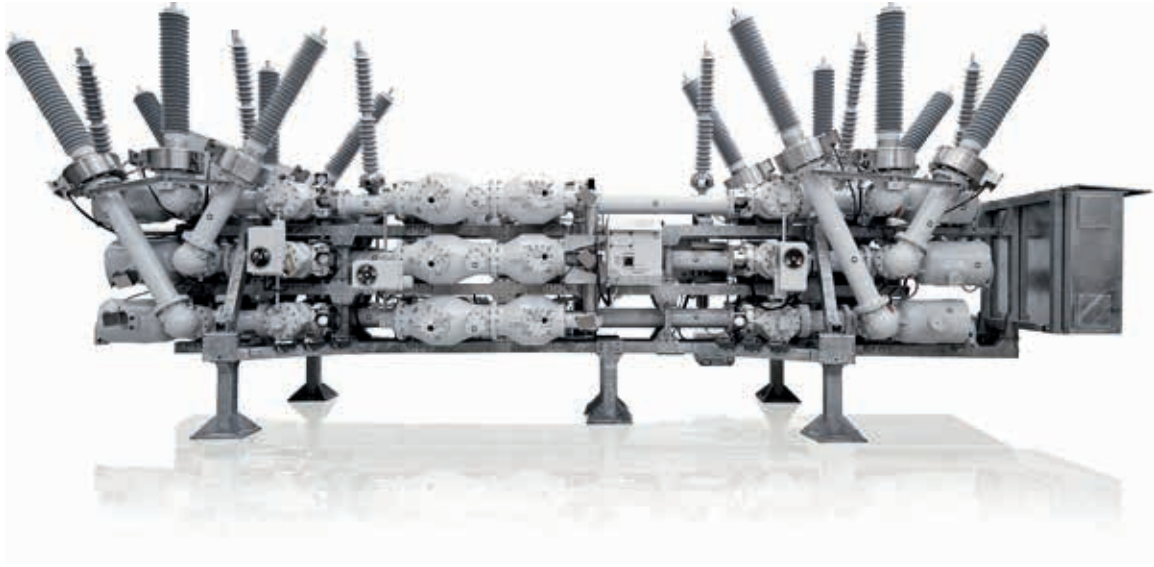
The preassembled and factory-tested PASS M0S 420 kV can be easily transported and quickly installed, without the need to assemble any active parts at the installation site.

#### PASS M0S 420 kV

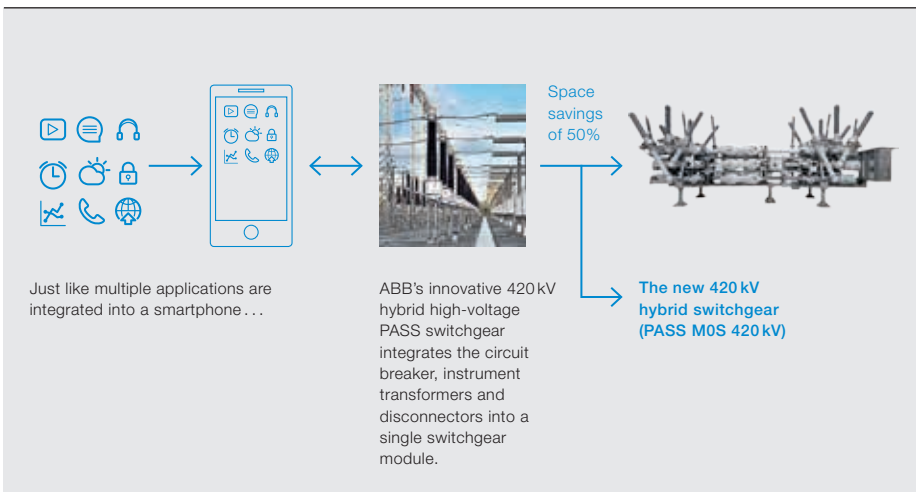
Since the launch of PASS, hybrid technology has become a very appealing

- On skid-mounted or mobile applications because the compactness of the module itself allows the whole bay to be transported more easily.
- For extension and retrofitting, as it is compatible with any type of GIS, AIS or hybrid substation.

alternative to AIS or GIS and other manufacturers have followed ABB's lead by adding hybrid switchgear to their offering. However, ABB maintains its technical leadership position by expanding the PASS portfolio to suit more applications and markets.



### 3 A PASS module integrates the functionality of many sub-systems into one product.



The PASS M0S 420 kV is the only 420 kV switchgear module that can be mounted and transported on a trailer or skid as a complete mobile solution from the factory.

With a PASS installed base of more than 8,000 units, in 2013 ABB announced the launch of the 420 kV high-voltage hybrid switchgear PASS M0S 420 kV.

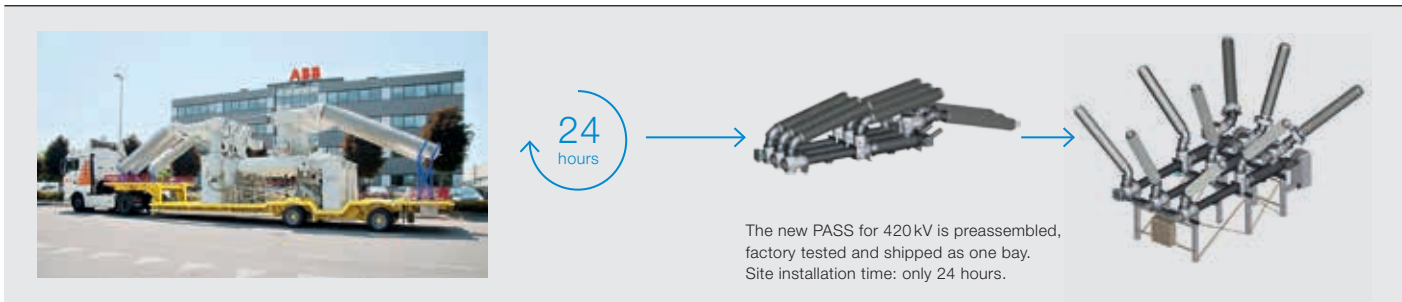
With the introduction of this new 420 kV module, the PASS product family now covers voltages from 72.5 to 420 kV with breaking currents from 31.5 to 63 kA. In addition to standard modules, a special solution called PASS M0H offers a complete high-voltage switchyard with an "H" configuration as a single transportable unit → 2.

The 420 kV PASS hybrid module is a technical breakthrough as, despite its larger size, it retains all of the PASS family benefits – such as the integrated functionality of a circuit breaker, disconnecter and earthing switch, as well as current

and voltage transformers, so that each PASS module is equivalent to a complete switchgear bay → 3. The preassembled and factory-tested PASS M0S 420 kV can be easily transported and quickly installed, without the need to assemble any active parts at the installation site. The PASS M0S 420 kV is the only 420 kV switchgear module that arrives on site completely assembled, so installation and commissioning is rapid → 4. PASS M0S 420 kV has further advantages:

- Maintenance is easy. For example, since all active parts of the equipment are gas-insulated, there is no need to regularly clean the switchgear contacts. Encapsulation also reduces overall servicing time and cost, and enhances reliability and availability. Often, operations can be carried out without the need for an outage.

4 The ease of transport of the PASS MOS 420 kV is one of its unique features.



The key innovation in PASS 420 kV is its rotating bushing concept.

5 PASS MOS 420 kV bushings in the transport position



- It is highly customizable according to clients' needs, yet, due to the modular design, it still has a short delivery time.
- The steel structure is compact so less civil engineering is needed.
- It can be mounted and transported on a trailer or skid as a complete mobile solution from the factory.
- Energization time is shorter – less than one week for a 420 kV bay.

The geometrical principle is simple: Each bushing is fixed to the rest of the equipment by means of two, curved, gas-insulated junctions, each made of an aluminum enclosure and internal electrical connections. This means the interface between the two parts is slanted, so that the rotation of the upper part (to which the bushing is mounted) moves the bushing from the nearly horizontal position required for transportation to a nearly vertical position for service → 5-6.

Rotating bushings

One of the biggest design challenges was the transportability of a fully assembled 420 kV module, given its large dimensions. As often happens, a major challenge like this provides the driving force for innovation. The key innovation in PASS 420 kV is its rotating bushing concept. To make transportation of the fully assembled product possible, the insulators (3.6 m, 350 kg) are rotated in the factory from the in-service position to the transport position, and back again at the installation site. This is made possible by an innovative and very safe bushing rotation design. The rotation takes less than 30 seconds per bushing.

The rotation is performed with the equipment filled by gas at 0.2 bar (relative), which is the pressure level typically used during transportation. One of the most significant features of the rotating interface is that it is exceptionally gas-tight during the rotation – as well as afterward, when the equipment is filled to the working pressure.

The curved junctions are well sealed. The lower enclosure hosts the grooves for two gaskets (one is a backup), protected by two backup rings that are located above and below the gaskets. The backup rings are made from a special composite material that can withstand huge radial loads with no deformation, while ensuring very low friction.



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The upper enclosure interacts with the gaskets and the backup rings via a machined cylindrical shoulder inserted in the lower junction.

Bushing rotation is performed typically only twice: into the transport position at the factory and back to the service position at the installation site. The sealing system was tested by performing over 50 rotations on the same equipment – with no leakage. ABB guarantees a leakage rate of under 0.5 percent/year, as is usual for ABB's SF<sub>6</sub> high-voltage devices.

Besides the insertion coupling for sealing, the two enclosures are also flanged and tightened with 12 bolts. Finally, a sliding ring is fixed to the flange of the lower tank in order to reduce friction during rotation.

The torque required for the rotation of such heavy components is provided by a commercial motor, which is applied to the rotation interface by means of a special tool, whose concept was patented by ABB in 2012. The rotation of the motor is fairly slow (around 2 rpm) but a complete rotation from the transport to the service position takes only around 30 s.

The bushing rotation facility is critical for the transport of this 420 kV device. Without it, the many benefits of PASS technology could not be made available to customers.

Since its launch, PASS 420 kV has caught the interest of several utilities with orders received from the United States, Italy and Algeria, among others, and advanced technical discussions have taken place with entities in Spain and the United Kingdom. These parties recognize the advantages of being able to quickly connect to the grid a solution that is delivered fully assembled and tested.

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**References**

- [1] W. Degen *et al.*, Cigre Working Group B3-20, Brochure 390 "Evaluation of different switchgear technologies (AIS, MTS, GIS) for rated voltages of 52 kV and above," November 2008.
- [2] W. Degen *et al.*, Cigre Working Group B3-20, Brochure 390 "Evaluation of different switchgear technologies (AIS, MTS, GIS) for rated voltages of 52 kV and above, Appendix A: "Introduction to Mixed Technologies Switchgear," pp. 44–56, November 2008.