Shunt reactors

Cost efficiency in power transmission

ABB Power Transmission
Ceramic spacer elements in steatite ensure limb rigidity for low noise.
Global leadership

ABB Transformers, part of global electrical engineering conglomerate ABB Group, commands a leading position in high/extra-high voltage shunt reactors. Uncompromising commitment to quality and technical excellence has generated exceptional customer loyalty. Since the introduction of the innovative gapped-core shunt reactor in the late 1960s, ABB Transformers has delivered more than 500 units to over 40 different countries. Deliveries cover the complete product range for high voltage transmission systems, including the 800 kV range, from 10-250 Mvar three-phase units to single-phase units designed for more than 100 Mvar. Unique know-how, advanced technology and superior manufacturing skills make ABB Transformers the natural choice, from single units to the largest and most challenging shunt reactor orders.

Local traditions

Drawing on a 100-year tradition of Swedish craftsmanship and technical innovation, Ludvika-based ABB Transformers has established a global reputation as a center of excellence in the field of shunt reactors. As Power Transmission Center for the entire Group, ABB’s Ludvika units number some 2,600 highly specialized employees. ABB Transformers is the world’s leading supplier of power transformers and reactors – and the largest supplier of high-voltage shunt reactors.
Shunt reactors for voltage control in your transmission system

Shunt reactors are the most compact and cost-efficient means of compensating capacitive generation in long-transmission high-voltage power lines or extended cable systems. Alternative solutions are more expensive, mean greater losses, require more equipment and demand additional resources. Placed permanently in service to stabilize power transmission, or switched in under light-load conditions for voltage control only, shunt reactors combine high efficiency and low life-cycle costs to cut transmission costs and boost your bottom line.

Reactor switching depending on load is factored into the design and does no harm to an ABB reactor.

Custom designed, custom built
The design and manufacture of shunt reactors demands advanced engineering know-how, quality craftsmanship and exceptional workshop cleanliness. Each core-type shunt reactor is unique, designed and built in close cooperation with the customer. Although visually similar to a power transformer in winding design and insulation - for optimum reliability/cost efficiency, and minimum life-cycle cost - inrush currents, linearity, harmonic generation and symmetry between phases are quite different.

Quality, craftsmanship and tradition
A rare combination of high-tech and individual craftsmanship, each shunt reactor is computer-designed to customer specifications, with a gapped core, crafted by specialists whose skills derive from a long Swedish tradition. There is no room for compromise: our reactors must withstand severe cold, severe heat, lightning and earthquake, as well as violent fluctuations in voltage. And exhaustive testing at our state-of-the-art laboratories ensures that, once on line, they stay on line!

Customized design
Using the latest computerized design techniques, each shunt reactor is a result of creative collaboration between project team and customer. Advanced computer software provides detailed knowledge of the magnetic field, to secure optimum design parameters in areas such as reactance calculations, eddy losses, winding hotspots, resonance etc. But it's people that make the difference. From computerized design through workshop assembly to delivery, installation and commissioning, our commitment to quality is total.

Sharp as a razor!
The heart of every reactor is its core. Our cores are made of high quality, radial laminated steel sheets, sliced razor thin down to a quarter millimeter.
Making a winding is an art acquired after long experience.
**Layered and bonded to form a massive core element**
The sheets are stacked tightly together to form “wedge” sections, which are inserted onto a circular base to create each core element. Radial lamination prevents fringing flux from entering the flat surfaces of core-steel, eliminating eddy current, overheating and hot spots.

**Steel heart, ceramic lungs**
Ceramic (steatite) air-gap spacers are bonded onto the core-steel cylinder with epoxy, to form a cylindrical core element. The tops of the spacers must be of precisely the same height. Once bonded, they are planed to ensure an even surface prior to adding the next core element. Even in the high-tech world of power transmission, this demands individual craftsmanship and a pair of vernier calipers.

**Rigid quality for minimum resonance**
Core elements are stacked and epoxy bonded to form a limb with a high modulus of elasticity – the “gapped core”. The magnetic field creates pulsating forces across all air gaps amounting to tens of tons, and the reactor cores must be extremely rigid to eliminate unwanted vibrations.

**Protecting the core**
To prevent fringe effects in the core elements and minimize eddy losses in the magnetic field, the core limb is wrapped in an electrostatic shield. This protects the core lamination from dielectric stress that can arise from the high voltage winding, eliminating the risk of partial discharges on the core surface.

**Winding is an art**
Our winding coils are handmade - literally. A skill only acquired after a long apprenticeship, winding quality and precision is crucial to reactor performance. For the highest voltages, the windings are divided into two parallel circuits with the line terminal at the center and two neutral ends at the top and bottom yokes.

ABB reactors can also easily be equipped with a secondary winding of limited rating for the power supply in the vicinity of the reactor. This auxiliary power may be either the primary or secondary power supply for station service in remotely located substations.
Hand-held high tech
The latest high-frequency brazing technology is used to join winding conductors. This microwave technique eliminates all risk of peripheral heat damage. The welding instrument is hand-held, for optimum flexibility.

Eliminating resonance
The frame must be designed so that its natural and fundamental frequency is above or below the excitation frequency, which is equal to twice the system electrical frequency. The unique means of flux redistribution between yoke and limb makes it possible to build the core frame so that the risk of resonance is eliminated.

Manual insulation
The insulation of internal interconnecting leads is also a manual process, to accommodate the broad range of shapes and sizes required.

Pre-tested for trouble-free installation
ABB Transformers’ laboratory is fully equipped for full-power testing, including a special test transformer for three-phase and heat-run testing, as well as testing facilities for even the highest voltage and Mvar power ratings.

These tests are designed to verify reactor integrity and performance criteria. They evaluate performance under full power load as well as when subjected to over-voltages that mimic the most onerous conditions experienced during network disturbances. The accurate measurement of losses is especially demanding, as the loss component in several respects represents a mere fraction of apparent reactor power: rather like trying to find a needle in a haystack.

Complete tests were recently conducted on a 133 Mvar, 800 kV single phase reactor in a 50 Hz system. Noise and vibration tests can be conducted on request. Customers are always invited to attend. Earthquake proofing analyses are conducted in association with ABB Research, Västerås, Sweden.

Packed with care
When ready for shipment, customers can rely on the same precision and commitment. The reactor will arrive in time, with full documentation and in perfect condition.
Shunt reactors (150 Mvar, 400 kV units) contribute to efficient long-distance power transmission from the north to the south of Sweden (1,574 km/984 miles).

Shunt reactor, in service since its installation in 1974. One of three units located on the Spanish island of Majorca. The reactors permit connection by submarine cable with neighboring islands.

TransEnergy, a division of Hydro-Québec (HQ), is more than satisfied with their compact, quiet-running and reliable 735 kV reactors, in general built as 55 or 110 Mvar single-phase units.
"Our reactors have now been in service for 26 years without problems!"

Antonio Carrasco Cañadas,
Maintenance & Service Manager, GESA, Palma de Mallorca, Spain

The customer
GESA, electric supplier for the Balearic Islands, is part of the ENDESA Group, one of Spain’s largest power companies.

Majorca has today no less than 32 substations. One, at Cala Mesquida, on the northeast coast, is different. It features shunt reactors from ABB.

Why shunt reactors?
GESA’s Antonio Carrasco Cañadas, explains: “In the ‘70s, GESA decided to centralize power production, linking the two previously separate electricity generating systems by means of a 40-kilometre submarine cable. Shunt reactors from ABB offered the best way to compensate for the reactive power generated by the cable. ABB Transformers delivered a total of five 132kV/30Mvar units which today, some 26 years later, continue to perform as well as the day they were installed. Three of these units are installed on Majorca, the other two on Minorca.”

Cost-efficient investment
“These shunt reactors have made a joint inter-island power grid possible. Concentration of power production to a single island conserves resources and makes a reserve power facility on Minorca superfluous: this translates into significant cost efficiencies.”

Shunt reactors from ABB made a cable connection between the Spanish islands Majorca and Minorca possible.
Any special requirements?
GESA demands that a shunt reactor supplier fulfil three key criteria: high quality, low losses and a reasonable guarantee period. Noise levels are of only limited significance: GESA’s shunt reactors are sited at rural locations, far from any habitation.

Good suppliers are the one’s you never need to call!
GESA’s Antonio Carrasco Cañadas also notes that ABB is a supplier that can be relied upon to provide whatever help and support may be needed, but adds:

“Actually, although these shunt reactors have now been in service for 26 years, we’ve never needed to contact ABB for help. They require only minimum maintenance - we just change the silica gel when necessary. And once a year, we close down the substation for a 15-day maintenance check, bringing in the reserve shunt reactor that has been on 12-month standby. This allows us to rotate our shunt reactors all the time, giving them regular ‘rest’ periods.”

Designed for survival
Hot, humid and salty, the island environment makes severe demands on shunt reactors. Surface treatment must be of the highest quality, and the reactors on Majorca and Minorca have proved highly resistant to the elements. Bushings were designed with extended creepage length, to avoid the risks posed by a salt-rich environment. Twenty-six years of trouble-free service is the best reference we can think of: we feel sure you’ll agree!

"Our shunt reactors from ABB are working very well and BPSB has required no technical support since commissioning."
Mr. Wang Jinding, Senior Engineer, Technical Adviser, Beijing Power Supply Bureau, China

"Since installing the reactors, they have given trouble-free service. Actually, we’ve almost forgotten that we have any!"
Mr. Thorkil Thrane, B.Sc.E.E, Substations, Eltra, Denmark
The customer
Svenska Kraftnät/SVK (The Swedish National Power Grid) was formed in January 1992, following the restructure of Vattenfall (The Swedish State Power Board). A state agency with system responsibility for a national grid comprising 15,000 kilometers (9375 miles) of power lines and some 150 substations, SVK can trace its roots back to the formation of Vattenfall, in 1909 – the same year its long collaboration with ABB’s precursor, ASEA, was initiated.

What makes a good supplier?
Hans Lundin, Purchasing Manager at Svenska Kraftnät, believes a successful customer/supplier relationship is almost organic:

“Our relationship with ABB on shunt reactors goes way back. Shunt reactors offer the most economical alternative to absorb reactive power. Today, despite increasing international competition, ABB retains a close relationship with SVK and the other power companies.”

Tough demands
“Fluctuations in temperature can be extreme – plunging to -50°C. Auxiliary equipment such as cooling systems and pumps must survive long periods in sub-zero daytime conditions, when shunt reactors are normally disconnected.”

“Shunt reactors must also satisfy a range of environmental demands like reduced noise levels. ABB has been so successful in recent years that we’ve got used to receiving equipment with noise levels way below our original specification!”

Exhaustive testing is critical
“Shunt reactors must perform trouble free: a malfunction could create a major problem. The supplier’s test equipment must be of the highest standard and capacity, able to subject the reactor to full-scale and fully realistic operating conditions. And it must be operated by highly skilled personnel.”

Does this make SVK a satisfied customer?
“Definitely! The substantial number of reactors we’ve purchased from ABB in recent years is ample proof. We know we always have ABB’s support – throughout a reactor’s entire lifetime. We know the people, we know the technology – and we have come to rely on both.”

“We always get the support we need!”

Hans Lundin, Svenska Kraftnät
Airlift may be an alternative in remote locations. We are proud to claim that we can handle any transport challenge.
Be our next satisfied customer!

Call your local ABB representative
The more complete your specification, the faster we can respond with a detailed and accurate cost estimate and delivery date. The following factors should be considered when specifying your shunt reactor:

| Reactive power, Q | Sound level and linearity criteria, if required |
| Rated voltage, U | Type of cooling, fan, pump, radiators |
| Maximum continuous operating voltage | Peripheral features, if required |
| Insulation level LI, SI (SS) | Safety and monitoring equipment |
| Frequency, Hz | Loss evaluation |
| AC test voltages | |
| Permissible temperature rise for oil and winding (monthly average) | |

Transport
Moving an object the size and weight of a shunt reactor demands planning, know-how and a global network of contacts. ABB has long experience of delivering reactors by rail, road, ship and even air - worldwide. Our skilled staff, locally and in Sweden, will ensure the entire process is fast and efficient.

Installation
ABB’s installation engineers will be on site to supervise installation and startup. On arrival, they will prepare the reactor by carefully reassembling all parts dismantled for transit, refill it with oil and conduct all necessary on-site tests to ensure long and trouble-free service. Customers can choose between a supervisory or full-installation agreement. As far as possible, the engineers assigned will have local language skills.

Training
The customer’s local operations and service personnel will be trained during installation and commissioning on site. Comprehensive training programs are available.

Service
Each shunt reactor comes with a technical guarantee and full backup, including field support and ABB’s renowned global after-sales service, through local branch offices, agencies and representatives throughout the world. As suppliers to the world’s power-generating industry, we share a tremendous responsibility: to keep the power flowing! Our quality products and highly trained service engineers are dedicated to this goal.
A rural idyll that could do you a power of good!

A “long” tradition
Though small in population, Sweden is a large and long country (1 574 km/984 miles), with “long” traditions – especially in power transmission! The concentration of hydropower capacity in the northern half of the country, the growth in industrial demand for power and the great distances between urban centers have made Sweden a natural pioneer of long-distance power transmission.

Ludvika, home of ABB Transformers, can trace its industrial roots all the way back to the mid-sixteenth century. Although 220 km (140 miles) from the Swedish capital, the country’s visionary ruler of the time, Gustav Wasa, felt its position in the heart of Sweden’s mining district, and he made it the ideal site for a hammer mill and cannon foundry. Small-scale mining developed steadily over the next two centuries, to be replaced by new large-scale industrial methods in the nineteenth century, resulting in a booming iron ore industry.

As the mining industry grew, so did its appetite for more and more energy, leading to the development of a local electrical industry. Elektriska AB Magnet, predecessor of today’s ABB Transformers, was therefore established in 1900. The company soon acquired a reputation for quality and innovation. During the 1930s and 1940s, it became established as a center of research and development, focused on high-voltage power transmission.

Today, as a Power Transmission Center for the multinational ABB Group, ABB Transformers is internationally recognized as the leading manufacturer of power transformers and shunt reactors for the highest power and voltage ratings. Exports account for more than 90% of sales.

In spite of all this industrial dynamism and commercial success, Ludvika retains the charm of a rural idyll. A town of some 14000 people, surrounded by lakes and rivers and close to the rolling hills and dales of the appropriately named Dalecarlia region, it is famous for its rich and varied wildlife (deer, beaver and elk), great fishing, skiing, mirror-like lakes and apparently endless hiking and biking trails – a must for any visitor to Sweden!

Ludvika continues to pioneer innovative technology for tomorrow’s power transmission systems – to the benefit of customer and environment alike. It seems only right that technology designed to do a power of good should derive from such a rural source!

Come see for yourself...

A green and relaxing environment helps the ABB Reactor team think creatively.
Environmental concern is integral to the manufacturing process. The plant's coexistence next to this school playground is a fine testimonial.

Research & Development
Cooperating closely with other R&D centers throughout Europe, as well as many respected universities and technical institutes, ABB Transformers coordinates the Group’s global R&D in shunt reactors and power transformers, investing an impressive 8% of total revenue. Research is concentrated to ABB’s four world-class laboratories, all in Ludvika: the High Voltage Laboratory, the Material Laboratory, the High Power Laboratory and the Swedish Transmission Research Institute.

Environment
Our shunt reactor program is optimized to reduce environmental impact to a minimum, in accordance with ISO 14001. Designed to compensate for the reactive voltage generated in the grid, they offer increased cost efficiency and reduced losses. Alternative options would increase environmental load in terms of additional material and resources, demanding more equipment and additional transformers (larger power stations).

Every stage of the process - purchasing, manufacturing (no heavy metals or hazardous materials), coating (water-based paints - no emissions), transportation, operation (low losses, low maintenance costs, leakproof) and scrapping (up to 95% recyclable) - is designed to minimize environmental impact. And at no extra cost to the customer.

Internationally approved Quality Assurance
Governed by the Quality Manual, in accordance with ISO 9001, the ABB quality assurance system comprises a complete set of specifications for everything from material and components purchasing to after-sales service. The system, which is constantly updated to meet new requirements, is subject to regular review by accredited international institutions.
Dry, clean oil – a condition of safe operation. Breather-air for the expansion vessel must be dried (dehumidified). When the drying agent changes color, the crystals must be replaced.