Power transformers

Phase shifting transformers
Reliable and efficient power flow control

Power and productivity
for a better world™

Eliminating bottlenecks in AC networks

Phase shifting transformers (PST) are crucial components in the ongoing strive for improved AC network efficiency. Increasing amounts of transmitted energy push the networks to the limit, increasing the risk of network instability. PSTs are a cost-effective means to ensure reliable and efficient power flow control in overloaded transmission lines.

Improved system operating performance and efficiency

PSTs allow you to control the power flow in the transmission grid independently of the generation. Total power flow is influenced by modifying the load share of parallel lines. System reliability is improved by mitigation of post-contingency overloads and of unwanted power transfer. By balancing the power flow in the network and optimizing the electrical power flow, grid owners can minimize the electrical losses in their system.

Reduced system operating costs

By avoiding system overloads and instabilities, the PST helps you to reduce both your operating costs and the impact of post-contingency situations on delivery of electrical energy to your customers.

Increased utilization of existing transmission lines

PSTs are often the most economic and reliable approach to power flow management and system design, enabling you to get more out of their existing assets. Existing transmission lines can be loaded up to the thermal limit without being overloaded. The investment in new lines can be postponed or even avoided.

Scope of use

- Load sharing of parallel lines
- Boost transmission capacity without violating the N-1 criterion
- Boost system reliability
  - mitigation of post-contingency overloads
  - mitigation of unwanted power transfer
- Allow access of new generation to the grid, for example wind turbine parks
- Remove bottle necks in the grid caused by bulk power injection

Improved system stability and power quality

Phase shifting transformers protect transmission lines and HV equipment from thermal overload, improve transmission system stability and control the power flow between different networks, for parallel long distance overhead lines or for parallel cables.

Load sharing of parallel lines

When power flows through two or more parallel paths between two different systems, their impedances will determine the load sharing between the paths. Any difference in impedances will cause unbalanced line loading. Typical examples are EHV transmission lines in parallel to HV transmission or sub-transmission lines. A PST inserted in the line that does not pick up sufficient load shall provide an advance phase shift, meaning that the load side voltage phasor should lead the source side voltage. Alternatively, a PST with retard phase angle could be inserted in the line that tends to overload.

Mitigation of post-contingency overloads

When two systems are coupled via long and highly loaded transmission lines, the trip of one line may cause a significant phase difference across the opened circuit breakers. Such a phase shift may be too large to allow immediate re-closure. Without a PST, you must wait for a low-load period with less phase angle difference. By using a PST, the phase difference can be compensated, allowing the lines to be reconnected immediately.

Another use of a PST in post-contingency is to increase the power transfer over some of the remaining lines of a transmission corridor in order to relieve lines that would be overloaded in an N-1 situation. In such a case, the PST could be on stand-by most of the time, only to be switched-in as quickly as possible when one of the parallel lines trips during a peak-load period.

Mitigation of unwanted power transfer

When generation and transmission are unbundled it may be attractive for municipal utilities (or they may be forced) to decommission or sell power-generating facilities. However, once the municipal utility is no longer in control of the generator, they have to increase the import capacity from the periphery of the city. Normally a city is supplied by at least two HV infeeds at some geographical distance and frequently the municipal HV sub-transmission network is a cable network with rather low impedances. Any phase angle difference between the infeeds drives significant transfer currents across the cable network. Increasing the import capacity by adding EHV/HV transformers at the periphery further decreases the impedance of the municipal network, thus increasing unwanted power transfer, which in turn causes losses or even overloads in the cables. PSTs placed in one or several of the infeeds can balance the phase angle difference given by the external transmission network and eliminate the transfer flows.

TrafoStar – quality throughout the production value chain

PSTs are highly complex power transformers, with more windings and tap changers than traditional power transformers and a large number of connections between the three phases. Since every unit is unique, a detailed insight into the transformer's design and the system environment in which it operates is essential. ABB's global design and manufacturing platform, TrafoStar, ensures quality throughout the value chain.

Robust and reliable

PSTs have the same robust design as any other ABB TrafoStar unit and offer the same outstanding short-circuit strength. The designs are fully verified, special attention is paid to transient voltage distributions on active parts, cooling, magnetic stray flux distribution and loss distribution by in-house developed design tools. The design tools are proven by more than a thousand manufactured units per year.

High efficiency and low cost

A modern core and coil arrangement and an optimized tank design support low electrical losses, enabling efficiency levels of up to 99.8 percent. Operating and maintenance costs are comparable to the costs of a net coupling transformer and therefore much lower than most power electronic devices. This makes the PST a very competitive alternative.

"Center of excellence"

ABB combined all of its phase-shifting transformer experience from its many different factories into one single location to create a "Center of Excellence" from which ABB can provide comprehensive expertise and support optimized, reliable design. The expected lifetime of a PST is in the same range as power transformers, i.e. up to 40 years.

On-time delivery

ABB is committed to delivering on-time. Thanks to modularized design, manufacturing and assembly, first class sub-suppliers and our excellent quality control, ABB exceeds its commitment on delivery.

Low sound level

ABB uses modern active part design, high quality core materials and precise manufacturing processes in order to achieve the lowest sound levels. We guarantee values down to 28 dB(A) at 150 m distance (note that quiet whispering is in the range of 35 db(A).)

Short pay-back period

By increasing the total transfer capacity while avoiding overloading during peak times, the PST helps to deliver reliable power to your customers. Payback periods of two–three years and less are possible and have been achieved already by increasing power delivery and avoiding transmission fees.

Environmentally friendly

ABB is committed to protect the environment. To support this, ABB introduced water-based paint for transformer corrosion protection back in 1995. This has reduced the content of solvents to less than five percent. The introduction of e-coating for pipes and smaller parts has reduced the amount of waste material.

One stop solution competence

ABB provides all of the following services as turn-key projects, from one single point of contact. This eliminates additional interfaces and miscommunication – and ensures hassle-free installation of a PST.

System design studies

System design studies are necessary to define the electrical characteristics of the PST. An iteration process analyzing system requirements, PST performance and total cost offers the most economical solution.

Protection and control

The protection scheme of a PST is unique and requires experience and know-how. ABB offers the necessary consultancy services and can supply the relays required. Depending on the topology of the system and other system components, e.g. cables or capacitor banks, the switching sequence of the breakers on the source and load side requires special consideration.We can provide you with a functional description or with a ready-to-use programmed controller based on your operational requirements.

Project management

Professional certified project managers will ensure professional execution of any order.

Testing

Testing a transformer with multiple tanks requires a top qualified team with extensive experience of these extraordinary testing procedures.

Quality deliveries from our specialized PST plant

PSTs are highly specialized pieces of equipment that require leading-edge design and manufacturing skills combined with stringent quality control. Only a few of these gigantic units are delivered annually from ABB's specialized plant in Bad Honnef, Germany.

600 MVA, 400 kV	
Customer	RWE/ Amprion, Germany
Delivery	One 600 MVA, 230 kV, ±20° unit
Purpose	To increase and balance the power flow between Germany and France
Year of delivery	2011

1630 MVA, 400 kV	
Customer	Terna, Italy
Delivery	Two 1630 MVA, 400 kV, +18° units
Purpose	To increase electrical power transfer from France into Italy and to increase system reliability
Year of delivery	2003

450 MVA, 138 kV	
Customer	KeySpan
Delivery	One 450MVA, 138kV, ±58° unit
Purpose	To balance power flow between 345kV and 138kV system and to increase import capacity
Year of delivery	2002

1400 MVA, 400 kV	
Customer	Elia, Belgium
Delivery	Three 1400MVA, 400kV, ±25° units
Purpose	Optimize power flow and increase system reliability on Belgium grid
Year of delivery	2007

Full support from transportation to training

Our phase shifting transformer services range from basic maintenance to advanced diagnostic assessments and onsite repairs.

Service

Each phase shifting transformer comes with a technical guarantee and full backup, including field support and global after-sales services delivered by local branch offices, agencies and representatives throughout the world. Diagnostic assessment, onsite repairs, upgrades and spare parts deliveries are available to customers worldwide.

Transportation

Reliable transportation is key to successful installation. Moving an object the size and weight of a phase shifting transformer requires planning, know-how and a global network of contacts. ABB has long experience in delivering transformers by rail, road, sea and even air – worldwide. Our skilled staff will ensure a fast and efficient transport process.

Installation

ABB engineers will be on site to supervise installation and startup. They will prepare the transformer by reassembling all parts dismantled for transit, refill it with oil and run the necessary tests to ensure trouble-free operation. 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 – contact your local ABB representative for more information.

Contact us

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