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Solid State Transformer: An Overview of Application and Advantages

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Abstract: ***Solid-state transformer (SST), Electronic power transformer or Power electronic transformer (PET) contain the transformer inside the AC-TO-AC converters or DC-TO-DC converters. SST is type of electric power converter that replaces a conventational transformer used in electric power distribution.SST carries the full power and provides the electrical isolation. This paper gives the information of the solid state transformers advantages and applications.***
Keywords: Solid-State transformer (SST), High frequency transformer, Electronic Transformer

I. INTRODUCTION

Transformers are widely used in power distribution and power conversion systems to perform many functions, Transformers are one of the heaviest and most expensive parts in an electrical distribution system. The size of transformer is a function of the saturation flux density of the core material and maximum allowable core and winding temperature rise. Saturation flux density is inversely proportional to frequency and increasing the frequency allows higher utilization of the steel magnetic core and reduction in transformer size.[1] The conventational transformer is totally passive and the volume and weight of conventational transformers are the concerning issues. As the technology matures and people gain a better awareness of what the smart grid demands for, new technology has to be investigated.

II. LITERATURE REVIEW

Solid state transformer is a collection of conventional high frequency transformers, high powered semiconductor components, and control circuitry which is used to provide a huge level of flexible control of power distribution networks, with some communication capability, the entire package is often referred to as a smart transformer. In the recent years, high power converter, named solid-state transformer (SST) has caught much attentation.[2]

Solid-state transformer consists of static converters on both the primary and secondary side exciting the transformer synchronously. The low-frequency input sine wave voltage (60 Hz) is first inverted at 600 Hz to 1.2 kHz by the primary-side static power converter, magnetically coupled to the secondary and then unfolded into a low-frequency (60 Hz) waveform by the secondary-side static converter.

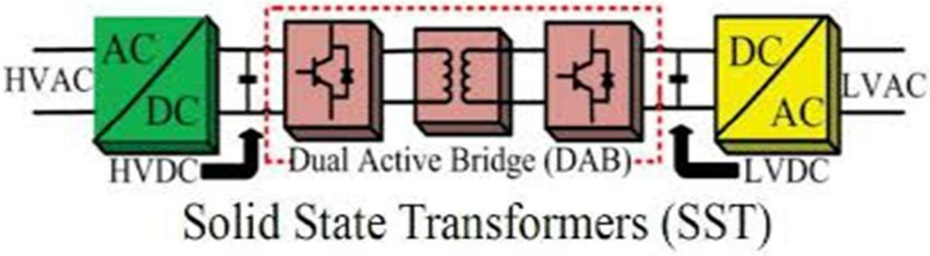
This operation requires both primary- and secondary-side static converters to be operated synchronously. In terms of electrical performance, the electronic transformer and the conventional transformer are identical.

Electronic transformer or solid-state has the following advantages:

1) Identical input/output characteristic as a conventional transformer.
2) Smaller size and weight (nearly 1/3 size reduction with standard steel core transformer).
3) Efficiency compatible with conventional transformer.
4) Electronic current limiting feature.
5) Does not require the use of input/output filters.
6) Good voltage regulation.
7) Snubberless operation due to four-step switching strategy.
8) No additional harmonics are generated due to switching.

Several topologies employing primary and secondary-side static converters in combination with magnetic core have been explored. By employing conventional grain-oriented silicon steel, an electronic transformer can process three times the power at 1000 Hz than at 60-Hz frequency.[1]

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The SST also constitutes the required infrastructure that will enable DC power distribution to homes and commercial buildings in the near future and provides a more efficient way to integrate storage devices and distributed generation into the electrical grid. In this sense the SST behaves as an energy router, which represents a key element in an intelligent power system.
The SST could replace several equipments of electrical systems which are added specifically to perform the aforementioned functions, namely capacitor and reactor banks, active filters, synchronous compensators, STATic synchronous COMpensators (STATCOMs), Static Var Compensators(SVCs), Dynamic Voltage Regulators (DVRs) and Unified Power Flow Controllers (UPFCs), leading to a simpler and more efficient power system, towards the deployment of a smart grid. [3]

A. SST Based Micro grid Can Provide

1) Fault protection, due to the converters current limiting capabilities,
2) Power factor correction;
3) AC input-output decoupling and isolation, hence disturbances occurred in one side of the SST do not propagate to the other side
4) Possibility to accommodate DC power distribution.

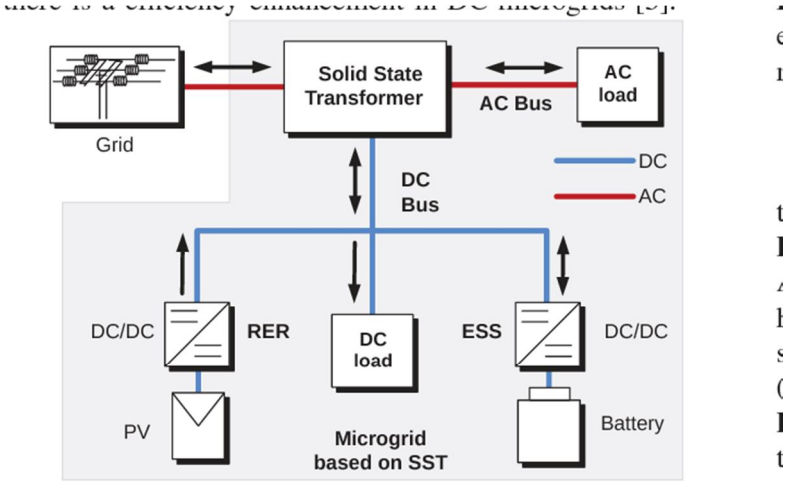
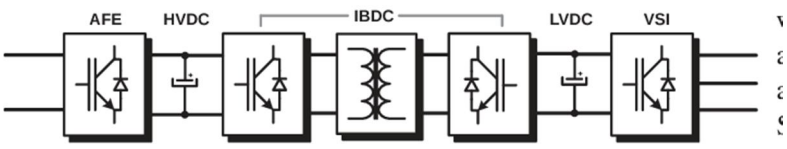


Fig. 2. Microgrid architecture based on SST.



SST can be used in many areas where conventional transformers are used. SST has many applications in different areas. The use of SST instead of power transformers depends upon the advantages of SST. Due to reduced size, weight and volume, high power density, higher efficiency, fault isolation, reactive power compensation and improved power factor, SSTs are mostly preferred.[2]

Comparison of Conventional Transformer and Solid State Transformer in Wind Power Integration

Conventional Wind Power Integration	SST based Wind Power Integration
Requires large number of power electronic devices like transformers, STATCOMs, converters, etc…	All the devices are replaced with a single unit –SST
Less power density	High power density
Overall size is increased and have huge weight and volume	Less size, weight and volume
High cost	Less cost

Comparison of Conventional Transformer and Solid State Transformer in DC Charge Station Conventional

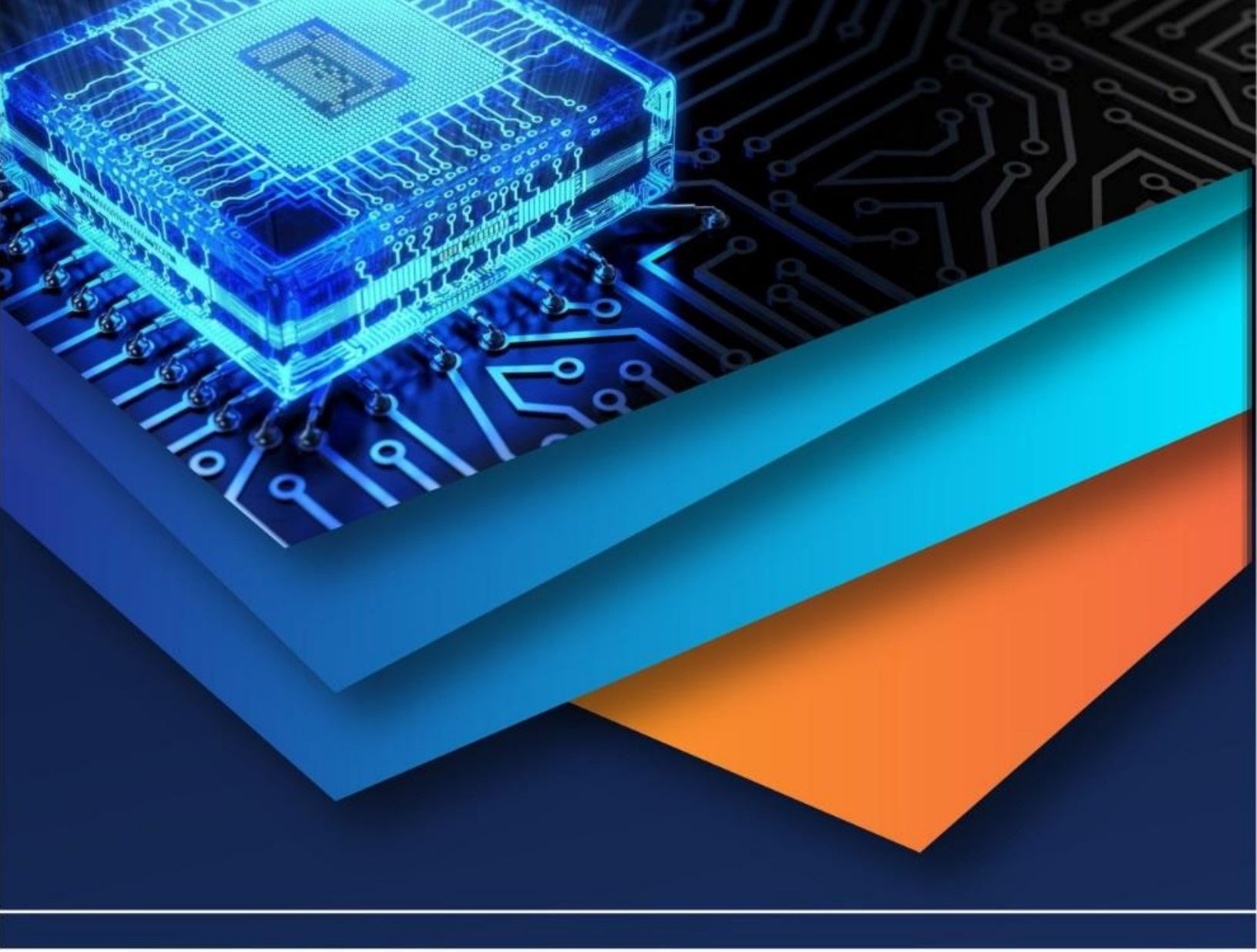
Conventional Transformers in DC Charge Station	SST based DC Charge Station
Efficiency: about 90%	Efficiency: about 95%
Less power density	High power density
Overall size is increased and have huge weight and volume	Less size, weight and volume
High cost	Cost is reduced to half of that by using conventional transformer
Less power quality	High power quality due to the properties of SST

III. CONCLUSION

Solid state transformer is highly popular in smart grid system. It is high- voltage, high -frequency operated power device. In comparison with conventional distribution transformers SST provide notable volume reduction, weight reduction, fault isolation capability, voltage regulation, harmonic filtering, reactive power compensation and power factor correction. By using SST over the conventional transformer in smart grid system the cost of installation, cost of transportation and cost of maintenance will be decreased.

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