

Flexible Power Electronic Transformer

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ABSTRACT

A new type of transformer name as Flexible Power Electronic Transformer (FPET), is proposed in this paper. Proposed transformer can perform various functions as voltage transformation, power quality improvements, reduction in size, galvanic isolation, and reduced losses. The flexible power electronics transformer (FPET) consists of power electronics converters on the both sides of the transformer which provides a new and most absolute approach in the design of transformer. This new transformer is able to meet future requirements of upcoming power electronic centralized power systems. Flexible power electronic transformer (FPET) has many features like instant voltage regulation, compensation of voltage sag and power factor correction. This paper proposed a topology of three stage flexible power electronic transformer (FPET). The design process consists of AC/DC converter/rectifier, DC/AC converters/inverter and high frequency transformer. Proposed flexible power electronic transformer (FPET) carry out common functions of a conventional transformer and additionally can carry out functions such as power factor correction, voltage sag and swell compensation, reduction in voltage flicker, improved protection capability in fault situations and reduction of size of the system.

Keywords—Flexible power electronic transformer, high frequency transformer, converters.

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I. INTRODUCTION

Transformer is a device which transfers electrical energy from one circuit to another with constant frequency. In every country, Transformer is one of the main device used in power system. Nowadays conventional transformer is one of the large and expensive equipment due to its massive iron core and heavy copper windings. To change voltage level the main solution in conventional transformer is by varying the number of turns so there are various problems like sparking and heat generation. In this paper, a new topology named flexible power electronics transformer (FPET) is proposed as shown in fig. 1. This new transformer uses a power electronics converter on primary and secondary side of transformer. Flexible power electronic transformer is a programmable device that can vary the voltage and frequency as per our requirements by using power electronic converters [1]-[3]. It has offered enabling technologies for power quality improvement, a considerable reduction in

size. FPET has all functions of conventional transformer like voltage transformation and good isolation additionally FPET also has many advantages like a considerable reduction in the size, power quality improvement, and Increased efficiency etc. these features of FPET make it ideal choice for power transfer in power system.

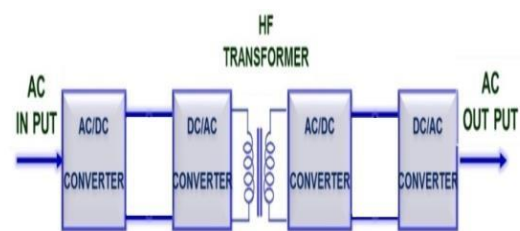
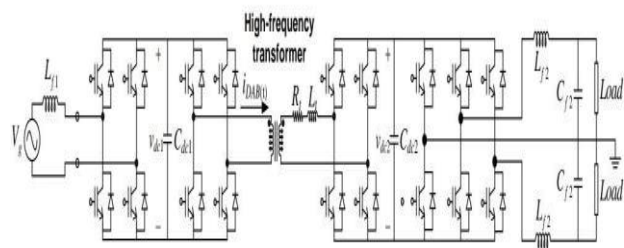


Figure 1: Block diagram of FPET

II. PROPOSEDSYSTEM

The proposed circuit is shown in Fig.2. Numerous topologies have proposed for the Flexible Power Electronic Transformer, consisting of single-stage, two-stage and three-stage topologies [4]. In recent years, different topologies have been presented for realizing the FPET and therefore the three- stage FPET topology is the most promising. Proposed topology has three stage 1) input stage (AC/DC), 2) Isolation stage and 3) output stage(DC/AC).



A. Input Stage

It is a single phase AC-DC converter/rectifier, which convert the primary voltage having low frequency into the equivalent DC voltage. Shape of current waveform is corrected at this stage to improve power factor. Voltage is regulated at this stage [2]-[4]. Fig.3 shows the structure of input stage.

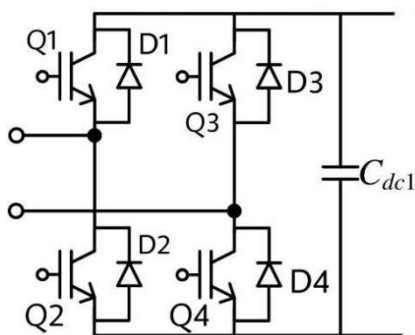


Figure 3: Structure of Input stage

B. Isolation Stage

Isolation stage consists of single phase DC-AC inverter, High frequency transformer and single phase AC-DC converter/ rectifier. Here input DC voltage from input stage is converted to high frequency (1 KHz) square wave voltage which is supplied as a input to the primary of the high frequency transformer. Hf transform erstep down the voltage [4]-[5]as per turns ratio. This voltage is converted to DC voltage by rectifier. Fig.4 shows the structure of Isolation stage.

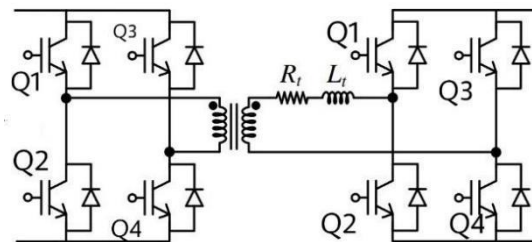


Figure 4: Structure of isolation stage

C. Output Stage

It is a single phase DC-AC inverter. which convert DC voltage into desired AC voltage having rated frequency. Fig 5 shows structure of output stage.

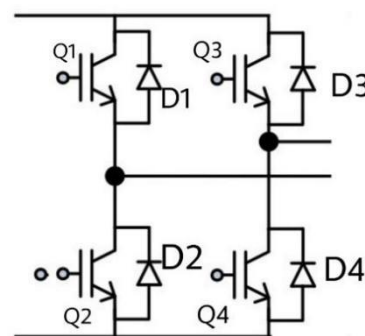


Figure 5: Structure of output stage

III. WORKING

The working of the FPET can be explained with the help of three stages input stage, isolation stage and output stage. The circuit diagram of FPET is shown in Fig:2. Single phase, 230V, 50Hz supply is given as a input to the AC-DC rectifier. AC-DC rectifier converts this AC voltage into DC voltage. This output DC voltage is given as input to DC-AC inverter. By using forced commutated DC-AC inverter this voltage is converted into AC voltage having desired voltage and frequency (High frequency). This output voltage having high frequency is given as input to the HF transformer. HF transformer performs the function of step up or step down depending on the number of turns. Secondary of HF transformer has high frequency voltage signal hence to convert this high frequency voltage into low frequency voltage this voltage signal is converted into DC voltage using AC-DC rectifier now using DC-AC inverter this voltage signal is converted into desired voltage and desired frequency (50Hz) voltage signal.

IV. FEATURES OFFPET

A. Advantages

- Provide active and reactive power compensation.
- FPET provide Flexible regulation of the

voltage and power.

- Eliminates the need of toxic dielectric coolants: mineral oil, beta oil, silicone are widely used coolant materials, cost of coolant higher and its replacement also difficult.
- It allows bidirectional flow of active power between the utility and the micro-grid.

B. Disadvantages

- FPET uses power electronics converters which has tendency to generate harmonics hence require special type of filters.
- As high frequency transformer is the main part of the FPET, obtaining high frequency is difficult tasks of designing is complex

C. Applications

- FPET can provide desired waveform in each phase independently, hence very useful in Universal Power Quality Conditioner (UPQC).
- FPET can transfer power from one phase to another phase this feature is very useful in distribution system for Interline Power Flow Controller (IPFC).
- FPET has a feature of providing symmetrical three phase voltage from an unsymmetrical ac source in the form of an Uninterrupted Power Supply (UPS) application.
- FPET is very useful in compact applications like mines, Aircrafts, shipboard, and indoor substations.

V. CONCLUSION

The Flexible power electronic transformer provides an alternative to conventional transformers however FPET cannot replace conventional transformers completely, but rather FPET is a multifunctional device where one of its functions is to transform one AC level to another. Other functions and benefits of FPET are absent in conventional transformers. The proposed topology is flexible enough to provide bidirectional power flow. The proposed system has more advantage at high voltage level.

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