

OPERATION OF VOLTAGE REGULATING TRANSFORMER IN ULTRA HIGH VOLTAGE TRANSMISSION LINE

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Abstract: The global is getting a population increased and electric energy usage is rapidly raised up. In order to meet this power demand, the usage of Ultra High Voltage (UHV) is needed. The main trend of power devices development has always on improving the power ratings while increasing the overall power device performance in terms of better controllability, reduced losses, increased robustness, and reliable behavior under normal and fault conditions. Less cost and Easy up keeping there is no power electronics elements is taken as the key constituent for the new resemble, noted as Voltage regulator. The multi winding provides serial voltage compensation and reduced power transformer is consist for voltage regulation. Different voltage compensation steps are get by changing the connection between the polarity of primary and secondary windings. The transformer design has focus to obtain a less cost regulator and high efficiency. This automatic controller optimal compensation step and automatic controller monitors. The results were analyzed in MATLAB/SIMULINK.

Keywords: Power Quality, PWM Switched Autotransformer, IGBTs, Power Distribution Control, Power Transformers, Voltage Control.

I. INTRODUCTION

Advantages of UHV technology: Transmission capacity has increased, Transmission distance has extended, Transmission losses has reduced, Land requirements has reduced. The revolution power electronics has power delivery and automation sectors across decades swept electrical energy is the wide range of possibilities is transported and used. The power semiconductor device is the heart of revolution lies has modulating the main task of energy flow to requirement of the application. The continuous improvement in device performance has enabled represent a Power semiconductors has important market sector in common terms cover an ever raising more number of applications. The very huge power applications in the megawatt range, defend a small but crucial market sector for semiconductor elements. The required of higher voltages and currents withstand a higher power rating their progress on technologies developed is large depend on initially for lower power applications.

Electrical energy source are solar cell, wind turbine and hydro power plants these alternative energy sources are used to make compensating power demands due to population and industrialized is challenge to deliver power from remote energy generation location. Voltage sag, swell, harmonics, transient and short duration of interruption are trouble the sensitive loads in an industrial process disturbances and increased usage of critical is the reason for economic less and

power quality issues. The huge network of river is similar to power distribution system. During power distribution any system faults the other power transmitting service is not damaged or interrupted is important to remove fault system only from the network. When an error occurs in power distribution system voltage of entire power system will be affected. Voltage sag, swell, interruption are the major of power quality problems. Voltage on phase drops specified allowance for a small period of time occurs is known as voltage sag condition.

Power quality in distribution system is to be looked as huge-period voltage fluctuation. Each country has various factors for voltage regulated standards are maintained in like supply voltage, power quality. Usually national rules are having more limiting voltage ranges. The amplitude value of voltage is an important quality issue, because the specific voltage range loads are designed to work correctly. Many problems in domestic, interior and industrial equipment are affiliated with long duration under voltages, such as defective in relays and contactors, incandescent lighting dim, switch-off of discharge lighting, failure of nonlinear loads and torque reduction in induction machines. Usually the overheating of loads is the result of long duration over voltages and hence reduction in their awaited durability. Urban distribution networks compared with Low voltage rural distribution systems are more convincible to long-term voltage

fluctuations, due to the propagate configuration of customers. The loads and the distribution transformer are usually associated with Voltage variations in rural areas long distances between them. The consolidation of uncontrollable broadcast generation in these networks is a new potential source of voltage fluctuation.

This paper deliver a new voltage regulator that fulfills the rural distribution networks needs: high efficiency, easy maintenance robustness, and low cost. Its power circuit and control system present the design of the voltage regulator describing in various sections. Regarding the design of the voltage regulator and the operation experience data of voltage regulators some practical considerations installed in the distribution network.

II. PRINCIPLE OF OPERATION

a) Grid Networks and Applications

The current grid system requirements are mainly influenced by the largely increased energy demands especially in heavily populated and industrialized urban areas plus the challenge to deliver power from remote energy generation locations which include alternative energy sources such as wind turbines, solar cells and hydro plants. Energy storage have also increased since their impact on the grid is of major importance. "Smart Grids" is often the terminology used for this evolutionary step for modernizing the entire Transmission and Distribution (T&D) network. Ultra High Voltage (UHV) transmission and Flexible AC Transmission Systems (FACTS) represent the two main system level enablers for achieving the goals.

Power electronic component of a PWM switched connected to an autotransformer load with series connection. The mitigating device and the control circuit logic utilized in the system. This single phase circuit configuration shows in Fig 2.1 of PWM switched autotransformer with Voltage sag mitigating device insulated gate bipolar transistor (IGBT) is contain a single PWM switch bridge configuration, a thyristor bypass the voltage controller and an autotransformer.

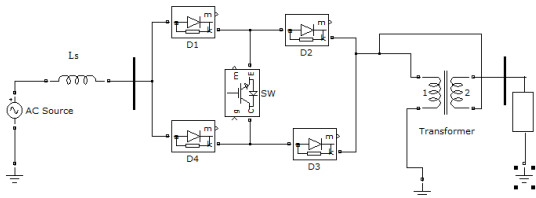


Figure 1: Diagram of PWM switched autotransformer

Sinusoidal PWM pulse technique is used in this system of voltage regulation. To maintains load voltage with constant rms with a suitable control circuit configuration connected and power flow direction control of IGBT switch (SW) ac voltage controller Four power diodes (D1 to D4) are connected. To inject the error voltage on the line power electronic device of an IGBT is used for maintain the load voltage constant. The reference rms voltage V_{ref} is calculated and compared with RMS value of the load voltage V_L .

At normal condition the error voltage V_{err} and $V_L = V_{ref}$ is zero. The antiparallel thyristors allow power flow is through them at normal condition. A notch filter and a main capacitor filter are used to filter out the switching noise and reduce harmonics at output side contain aoutput filter. The voltage sag or swell occurs due to sudden raise or falls in the load. The Load voltage V_L and hence supply voltage V_S reduces IGBT are blocked by gate pulses.

When the sensing circuit detects an greater than an error voltage V_{err} . The normal voltage the voltage controller acts immediately to switch off the thyristors. Voltage V_{err} applied to the pi controller gives the phase angle δ . The control voltage given in Eq. (1) is constructed at power frequency $f = 50\text{Hz}$.

$$V_{control} = m_a * \sin(\omega t + \delta). \quad \dots\dots(1)$$

Where,

m_a is the modulation index.

The phase angle δ is dependent on the percentage of disturbance and hence controls the magnitude of $V_{control}$. This control voltage is then compared with the triangular voltage V_{tri} to generate the PWM pulses V_G which are applied to the IGBT to regulate the output voltage. Hence the IGBT switch operates only during voltage sag or swells condition and regulates the output voltage according to the PWM duty-cycle. To suppress the over voltage when the switches are turned off, RC snubber circuits are connected across the IGBT and thyristor.

b) COMPENSATION of VOLTAGE SAG

The employed for realizing is AC converter topology the voltage sag compensator. This paper considers for output voltage control the autotransformer that use only one PWM switch of the input voltage shunt type is used in the proposed system to boost instead of the voltage mitigation scheme a two winding transformer. The autotransformer is the primary side of Switch IGBT.

$$\frac{V_1}{V_2} = a = \frac{I_s}{I_l} = \frac{(N_1 + N_2)}{N_1} \quad \dots\dots(2)$$

Where,

V_p = Primary voltage;

V_l = Secondary voltage;

I_1, I_2 = primary and secondary currents,

respectively;

I_s = Source current;

I_l = Load current.

The voltage and current distribution in the autotransformer it does not provide electrical isolation between primary side and secondary side but has advantages of high efficiency with small volume. The compensator considered is a shunt type as the control voltage developed is injected in shunt. The relationships of the autotransformer voltage and current are expressed.

III. DESIGN of RIPPLE FILTER

The 50Hz at switching frequency and harmonics is the pulse containing fundamental component of given by the IGBT of output voltage.

$$|z| = \sqrt{R^2 + \left(\omega L_r - \frac{1}{\omega C_{r2}}\right)^2} \dots\dots(3)$$

Where,

R, L_r , C_{r2} are Notch filter resistance, inductance and capacitance.

IV. MATLAB SIMULATION OF PWM SWITCHED AUTOTRANSFORMER

MATLAB/SIMULINK model of a 3-phase used for voltage sag studies

Simulation analysis is performed a three-phase, 50 Hz system to study the performance of the PWM switched autotransformer in mitigating the voltage sag and swell disturbances. The MATLAB/SIMULINK model of the system used for analysis. A RL load is considered as a sensitive load, Shown in Fig 3 which is to be supplied at constant voltage.

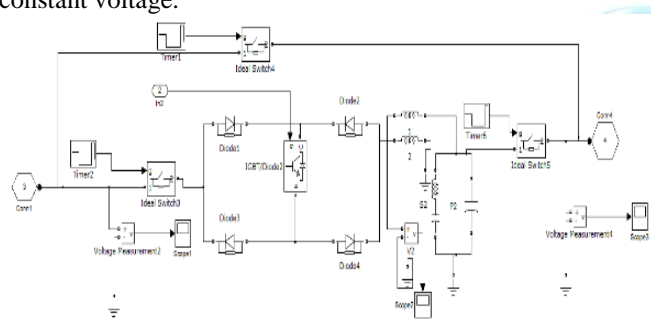


Figure 2: .Model of 3-φ PWM switched autotransformer

The system parameter specifications used for simulation. Under normal condition, the power flow is through the antiparallel SCRs and the gate pulses are inhibited to IGBT is shown in Fig 3.2. The load voltage and current are same as supply voltage and current.

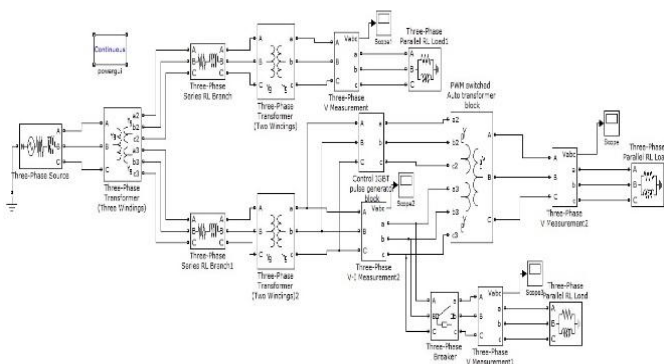


Figure 3: .MATLAB/SIMULINK Model of 3-φ used PWM switched autotransformer

The IGBT to obtain the load voltage THD within the limits to the load voltage hence suitable ripple filter at the output there is a necessity to design. The fundamental component are used A notch filter to remove the harmonics and a low pass filter and leakage inductance form the low pass filter for capacitor control in combination with source inductance.

When a disturbance occurs, an error voltage Shown in fig 3 which is the difference between the reference rms voltage and the load rms voltage is generated.

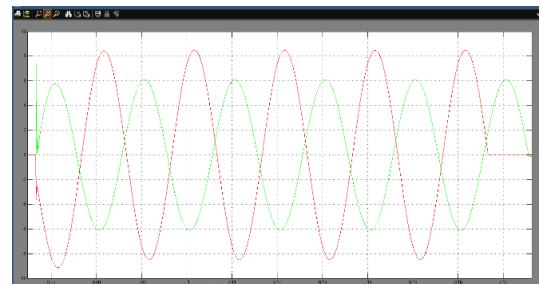


Figure 4: Simulation waveform for per phase error voltage in RMS value

The PI controller thus gives the angle δ . Control voltage at fundamental frequency (50 Hz) is shown in Fig 3.4 generated and compared with the carrier frequency triangular wave of carrier frequency.

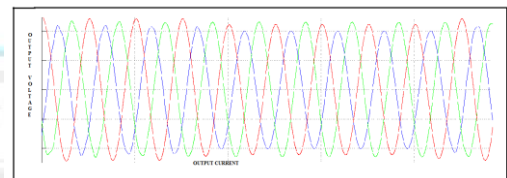


Figure 5: The simulation waveforms of the load voltage for voltage sag

The PWM pulses now drive the IGBT switch. The simulation modeling of PWM switched Shown in Fig 3.4. autotransformer used as mitigating device along with its control circuit.

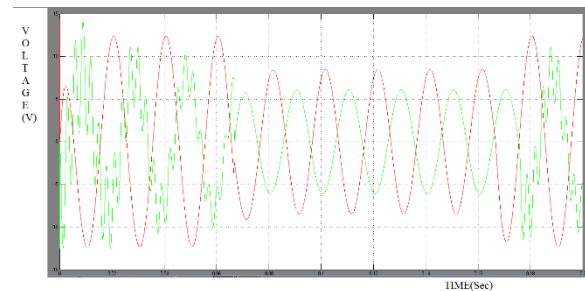


Figure 6: Simulation waveform for voltage sag mitigated using PWM switched autotransformer

It is important to remove any system faults so that the rest of the power distribution service is not interrupted or damaged. When a fault occurs somewhere in a power distribution system, Shown in Fig 3.5. the voltage is effected throughout

the power system. Among the various power quality problems, the majority of events are associated with either a voltage sag or a voltage swell, and the often cause serious power interruptions.

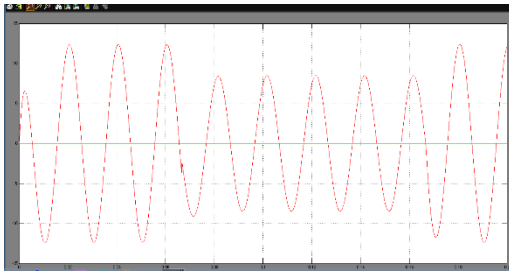


Figure 7: The simulation waveforms of the load voltage for voltage swell

A voltage sag condition implies that the voltage on one or more phases drops below the specified tolerance for a short period of time in Figure 7.

V.FUTURE WORK

The discrete serial Voltage compensation provides a proposed voltage regulator. The combines two regulation principles of Voltage is using tap switching compensated, which: voltage ratio regulation and polarity selection. The network fed from two independent primary windings with transformer has voltage regulator and compensation of secondary winding are serially connected. Compensation between the primary and secondary windings values can be obtained by changing the difference connections, using four poles, three power contactors with each. The optimal voltage compensation connection are automatic controller measures the output voltage and selects.

The characteristics of the proposed project make it eligible for the require of rural distribution networks:

Regulation of Step voltage : The required quality range voltage is adjusted within, and for industrial or commercial applications in rural networks there is usually no required for an exact voltage regulation based on small steps or continuous regulation. **Robustness:** For greater reliability and easy maintenance, electro-mechanical contractors are preferred to power electronics. The voltage regulator will be usually placed Out-doors, in dispersed locations, some of them with difficult-access. **Low cost :** Using serial voltage compensation instead of a full power converter reduces the device size and cost, increasing the efficiency notably. Moreover, the maintenance costs by the higher reliability reduces.

VI.CONCLUSION

The proposed design has some main advantages According to the analysis presented in the paper are following. The desired compensated voltage and maximum supplied current are depends on the rated power of the proposed voltage regulator. Therefore, conventional voltage regulator or transformer is smaller and cheaper than the voltage regulator design. Moreover, conventional voltage regulation devices

higher than the efficiency of the proposed voltage regulator. Lowest unitary weight and size where require to proposed design for cost evaluation purposes, comparison of unitary weights and sizes. In addition, voltage regulator proposed system has the best minimum efficiency equated with the studied commercial regulators. A cheap alternative is this voltage regulator by the step compensation provided. The use of striking to select between the different equipment compensating steps makes more reliable. Furthermore, it has lower costs and is more easily maintained than the regulators found on power electronics. The device is mechanically fragmented from the distribution system, which guarantees the persistence of the power supply. Observationalrecords for the functioning of their reliability have shown installed voltage regulators, high efficiency, and their capacity to better power quality in rural systems.

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