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DEVELOPMENT OF HYBRID SMART GRID USING MATLAB/SIMULINK

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Abstract

Modern domestic and commercial loads nowadays include the devices containing the use of power electronics. In our home we all use the electronic equipment such as computer, television, battery charger and fluorescent lamp which considered as power electronic equipment. Because of the non-linear nature of the electronic loads different major problems occurs like voltage sag, sell, harmonics, power factor etc. This non-linear load produces harmonic current in power system. Harmonic current causes the waveform that becomes nonsinusoidal. This harmonic component can be measured as total harmonic distortion (THD). In this research we will focused on the protection of the devices from THD, we use smart switch that will operate within certain time period and disconnects the load from the supply. The entire proposed model with controlling methodology has been implemented in MATLAB/SIMULINK from the result it is observed that when THD >0.9 the breaker will auto cut the supply.

1. Introduction

In recent years, most of the load that are widely used in domestic, industrial or agriculture purpose are non-linear in nature. It has been noticed from past 10 to 15 years that the loads which are being used in modern housing is now likely to contain a variety of worldly devices mostly powered and controlled through power electronic systems which are rarely seen a decade ago. Such devices are non-linear loads. Due to advancement of power electronics technology, non-linear loads in the system are rising, such as rectifiers, inverters, uninterruptible supply system (UPS) etc. The power

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quality is falling down day by day due to the excess use of power electronic based devices which have non-linear nature of the current and voltage. Increasing non-linear loads cause various undesirable effects and power quality problems. In this paper, the power quality problem that we will go through, and study is the total harmonic distortion (THD).

Power quality has become a topic of discussion nowadays in the electric power generation and distribution. The main aim of the power system is to provide the pure sinusoidal voltage at constant magnitude throughout the distribution. But many intricacies come across and the major obstacle observed is to provide the pure power without any harmonics or distortion to the consumer level. This is because of the various non-linear loads at the consumer level which produces the harmonic current in the power system. Due to this harmonic component the system performance is directly impacted in different ways. Harmonics is one of the major power quality issue in industrial and commercial power system. These harmonics in supply system has severe impacts such as heating of appliances, voltage sag and swells, poor power factor etc. The work in this paper is mainly focused on the protection of the power electronic devices containing non-linear load. The main objective of this paper is to extract maximum power and to maintain the power quality as it leads to increment in efficiency, saving of economy and proper utilization of appliances. To protect the device from high THD, smart switch is used that will auto cut the supply when the THD crosses its limit. The effectiveness of proposed model with control techniques are verified in MATLAB/SIMULINK environment.

2. Harmonic Distortion

In recent years, with the increasing use of power electronics, the quality of electricity supply, together with energy efficiency, has become a key issue. The main representation of power quality is the harmonic distortion, which represents the deviation between the ideal sinusoidal waveform the network voltage or the load current should have, and what really it is. In general, harmonics will not immediately damage or destroy equipment unless a resonance condition is encountered.

Some of the effects the harmonic can cause, to the equipment, to the

installation, or both, are:

- Added efficiency losses to the system composed by electrical installation and equipment.
- Unexpected resonances.
- Disturbances in electronic equipment, causing "logical" faults in digital circuits.
- Unwanted overload (or need to oversize) for transformers, wirings.
- Malfunctions of motors and generators, Unwanted Circuit Breakers tripping or Fuses blowing.

THD is defined as the ratio of the root mean square value of the harmonic component to the root mean square value of fundamental component and is generally expressed in percentage.

3. Modelling and System Analysis

In this section, the proposed smart switch integrated with a hybrid system is illustrated in a simulation model. The proposed model is consisting of three phase source, three phase V-I measurement, universal bridge as diode, three phase circuit breaker, controller. Sensitive load is connected to controller, which is used to control the breaker operation. The schematic Simulink diagram of the proposed hybrid system is shown in figure 1.

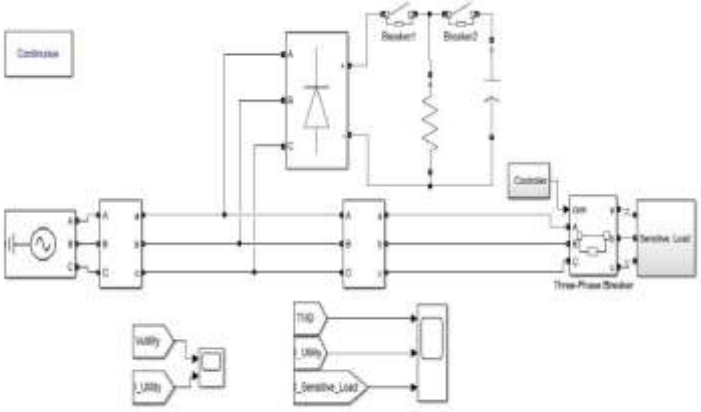

Figure 1. Simulink Model of Proposed System.

4. Modelling of Smart Switch

Smart switch in this proposed model is nothing but a three phase circuit breaker whose external mode is connected to the controller. Controller will provide the logical signal which is used to control the breaker operation. The sensitive load which is connected to the breaker will automatically stop receiving the current or we can say that the supply will be autocut by the breaker when controller sense the high value of THD. Hence, it is termed as 'smart switch'. Figure 2 shows the Simulink diagram of controller.

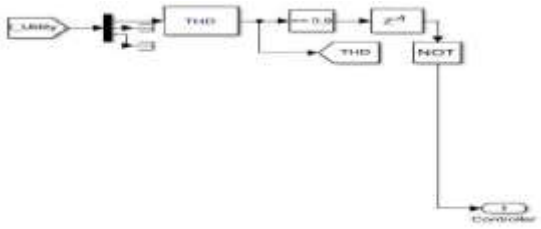

Figure 2. Simulink Diagram of Controller.

5. Results and Discussion

The results obtained from the Simulink model of the hybrid system is discussed below:

1. Figure 3 shows the sinusoidal waveform of the V_ Utility i.e. voltage of the supply.

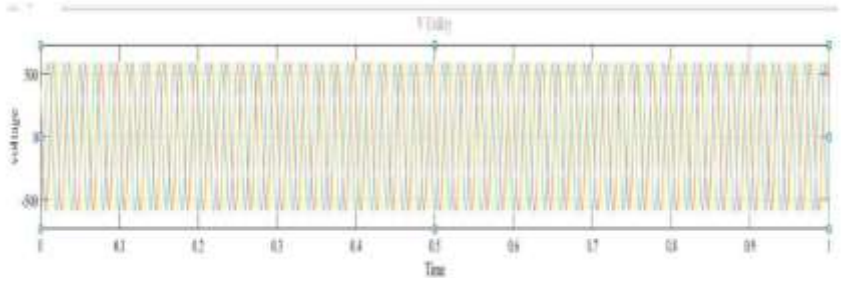

Figure 3. V_Utility Waveform.

2. Fig. 4 shows the waveform of the I_Utility i.e. the current of the supply. Here we can see that the waveform is having three different nature, first

part-between 0-0.2 sec the waveform is sinusoidal in nature, after that due to the non-linear load waveform between 0.2-0.5 sec is showing harmonics, as time increases the non-linearity of the waveform increases it means harmonics (THD) increases.

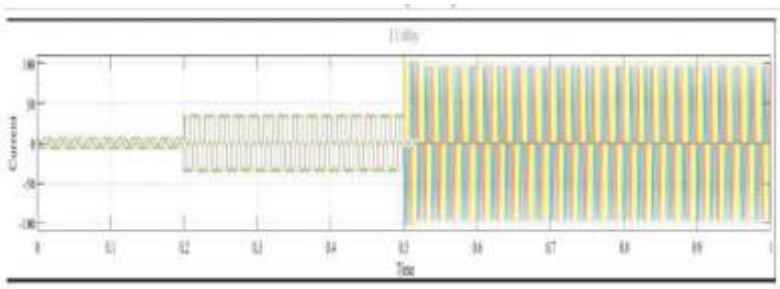

Figure 4. I_Utility Waveform.

3. Figure 5 shows the comparison between the value of the THD, I_Utility, I_sensitive load. We can see that the value of THD is constant for 0-0.2 sec, it increases with time and after 0.5 sec THD > 0.9. So, according to the proposed simulink model the sensistive load should not operate on high THD (> 0.9). When a non-linear is applied at 0.2 sec, the controller checks the THD of I_Utility, but since it is less than 0.9 it doesn't take any action and sensitive load remains connected to the utility. But at 0.5 sec the nonlinearity increases causing the THD of I_Utility to cross 0.9, now controller waits for 2 cycles and then disconnects the sensitive load from the utility.

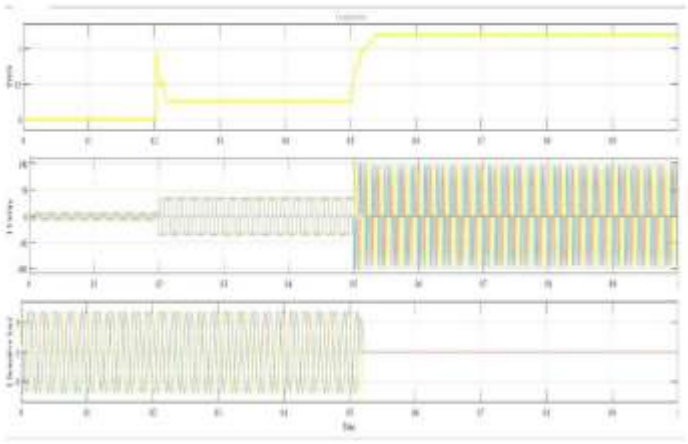

Figure 5. Comparison between THD, I_Utility and I_sensitive load.

Nowadays we are focusing on STATCOM for utility applications, where the STATCOM system is connected into transmission system between generation and end user. It is providing reactive current into electric transmission system to control voltage and boost network stability and reliability. When power generated, is measured in MVA, MVA is made up of two components-MW (real power) and MVAR (reactive power). In ideal power system power required by the end user, the MW is 100% of the generated power, little to no reactive power is required is to system.

In real world however, inductive devices which is motors, transformers and other power electronics devices exist in system, these devices consume reactive power. STATCOM is a reactive power source that uses complex control systems and IGBT's switches to dynamically control reactive power. But as discussed earlier STATCOM system is connected into transmission system between generation and end user, so we can't connect the STATCOM everywhere specially at domestic level. The harmonics produced by the nonlinear load in homes effects the other nearby devices as well. So, by using the 'smart switch' we can protect the devices specially the home appliances. The main aim of the proposed simulink model is to detect the high THD due to power electronics devices and protect them by autocut of the supply.

6. Conclusion

In smart grid applications, the protection of electronics devices by use of smart switch is proposed. The high value of THD due to non-linear loads can cause to damage to the electronic devices. To overcome this problem the smart switch will come into operation to protect the device. This technique is implemented for tracking the high value of THD. The simulation results are compared this technique. The entire proposed model with controlling techniques has been implemented in MATLAB/SIMULINK environment. From the results, it observed that when THD > 0.9, the controller waits for 2 cycles to check that the high value of THD is continuous not intermittent and then disconnects the sensitive load from the utility. From the results, it is observed that the proposed model and its control approach provides the acceptable performance optimization of the Smart grid system.

7. References

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