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Protection to Grid Tied Converters and Power Quality Control using Active Shunt Filter

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***Abstract*: This paper deals with the study of power quality issue and, simulation and implementation of a power electronic converter system to improve the power quality and protection to the converters. The present work is simulated for power system employing Active Shunt Filter (ASF) and Thyristor Switched Capacitor (TSC). The behavior of the power system for a designed controller with and without fault is simulated, and the results are presented in this paper. The experimental prototype for the overall system is implemented with the help of the solid-state circuit breaker (SSCB). The simulation is done with the MATLAB/Simulink, and the simulation results are verified with the prototype results, and finally, results are compared and presented for future work.**

***Index Terms*: ASF, Fault location, Power electronic converters, Power quality, TSC.**

I. INTRODUCTION

The traditional power systems have problems such as fossil fuels depletion, less energy efficiency and pollution etc. Also, an increasing power demand for quality and reliable power transfer has pressure on the conventional power system. These problems have paved the way for the generation of power at the distribution voltage level with the help of renewable energy sources like solar, wind, hydro, natural gas, fuel cells, biogas, etc., [1]-[2]. Nowadays, due to the increased use of distributed generation (DG), there occurs a drastic change in power system composition. This, in turn, affects the power system from providing a protected supply with high power quality. The efficiency of the DG has been enhanced by the growths in the field of power electronics. Placement of the inverters and interface with DG diminishes the maximum load and progresses the quality of the power [3]-[5].

As the power electronic converters that are used for loading system, adds further, the problem of power quality. The total impedance of the sources at any instant plays the vital role in addressing these problems, and the invention of impedance monitoring paves ways for active filter control. The impedance calculation added with the usual process of the grid-tied apparatus such as rectifiers and the ASF [6]. The measurement of filter line current/voltage provides an assessment of system impedance changes. The small adjustment is made for the introduction of minimal disturbance on PEE's PWM strategy which excites the impedance of the system, and the system voltage and current transients determine the supply side impedances. The invasive methods are used if and only if when non-invasive method defines a important modification in the system [7].

The term microgrid (MG) is well-defined as a collection of electrical loads, distributed generation system and the energy-storage system that operate in synchronization with the power system at the distribution level. The point at which MG is connected to the utility grid is called point of common coupling (PCC) [8]-[9]. The PEE's line current and line voltage of PCC is found to be 162ms before injection of transients and 165ms after transient injection to get desired resolution for measurement of impedance. The above-said response time for estimation strategy is found from the literature survey. In this article, the capturing period of data is considerably reduced to 5ms after the transient, and it reduces the requirement of pre-transient data. The reduction of capturing period is only because of Continuous Wavelet Transform (CWT). CWT is one of the transforming methods used to progress the current and the voltage transient to find the source impedance. So, the filter and TSC presented in this paper can able to determine the supply side impedance change during half of the supply cycle [10].

Voltage source inverter based MG is being developed and designed with the different control strategies focusing on harmonic free sinusoidal voltage and current to the power system even when the non-linear loads are connected or under grid voltage disturbances [11]-[12]. A different control strategies for the DG based on the micro-sources is presented in [13]. Also, the author of [14] presented a various control strategies under unbalanced grid-fault conditions. The behaviour of the inverter under different operating condition like utility power failure, frequency variation, inverter side harmonic currents, and the fault current in grid-tied system has been validated in [14]. It concludes that an intelligent controller is required for the inverters in the MG system which has voltage support, and the reactive power control to disregard the harmonics.

This paper presents the new strategy for real-time impedance estimation. Also, the strategy is experimentally proved with the furnished results. This paper may describe the estimation technique which is to be used to locate the faults in a distinct power system zone. For real-time supply side impedance measurement, identification of fault and location of the fault is essential, and it may be used in the renewable energy system, and in power grids. Moreover, it is also used in electric aircraft and electric ships [15].

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In the paper, ASF and TSC are used which can compensate both current harmonics and three-phase power system power factor. The compensation of reactive power is done with the help of TSC. This paper is organized as follows: Section 2 presents the impedance measurement techniques. In Section 3, the operation of the shunt active filter is explained. Section 4 explains the operation of the thyristor switch capacitor. Section 5 discusses about the usage of the solid state circuit breaker. Simulations and hardware results are discussed in section 6. Lastly, section 7 concludes the paper.

II. POWER SYSTEM IMPEDANCE MEASUREMENT

The block diagram for power impedance measurement is shown in the Fig. 1. To measure the source impedance, a small disturbance is introduced on PCC, and the transients of the voltage and current is analysed. By controlling two successive cycles of PWM in PEE, the disturbance is developed, so that, a small disturbance is injected into the power system. The above-said operation is implemented by designing PEE as an active filter and, is shown in Fig. 2. The filter inductance will produce a current spike with an approximation of 1m long and 22 A current peaks, and it is injected into PCC. The proposed method is used to determine the current and voltage transients on the source side by Continuous Wavelet Transform [16]-[18]. An interpolation routine determines the impedances at harmonic frequencies and that impedance to the source under such frequencies be discarded. Also, this method will estimate the impedances at 5th, 7th, and 11th harmonic, and it will use the reference signals for the ASF. The demonstration of control of an active filter will exhibit the operation of an active shunt filter in standalone mode. CWT is not having fixed time window like in Fourier transform, but according to frequency range, it will adjust the window. CWT is a processing tool which will analyse the transient signal. This paper uses both the voltage and current measurement to find the power system impedance.

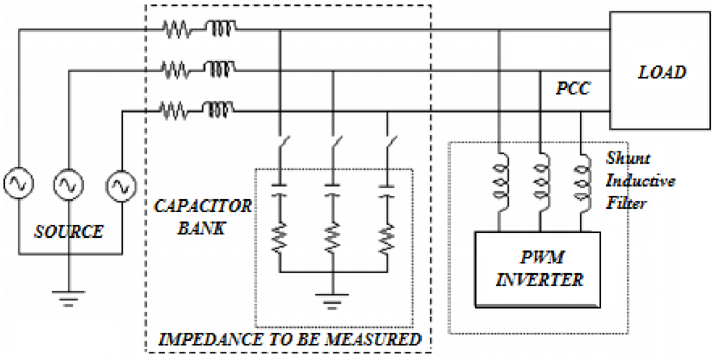

Figure 1. Block diagram for power impedance measurement

III. OPERATION OF AN ACTIVE SHUNT FILTER

ASF can able to compensate current harmonics and power factor for 3-phase systems with a grid-tied inverter. Furthermore, it will block the current flow in neutral cable and also it allows load balancing. Active shunt power filters present the versatile solution for quality in voltage. The principle of ASF is to make use of power electronic switched to generate precise current which terminates the current harmonic due to the non-linear load. Currently, PWM converters are designed and connected to low and medium voltage distribution system in shunt or series with the grid. Series active filters are operated in combination with passive shunt filters to compensate the load current. Shunt filter is operated as controllable current sources, and series filters operate as a controllable voltage source. Both filters are implemented with voltage source PWM inverter with a DC bus which has a reactive capacitive element as a filter. Active filters will compensate for the power system and improving power quality.

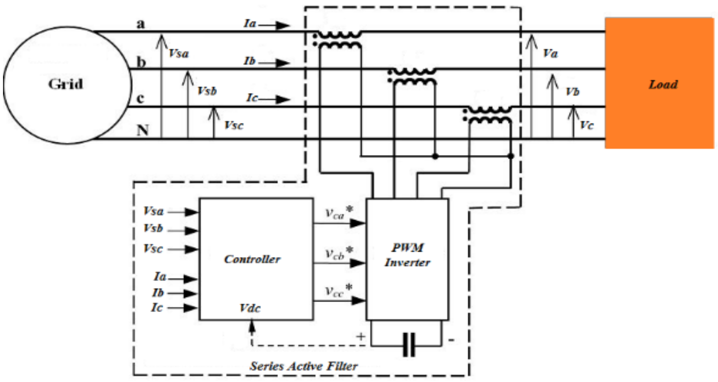

Figure 2. ASF in a three-phase system with neutral wire

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Fig. 2 shows the circuit for active shunt filters in a three-phase power system with the neutral wire. The principle of active shunt filter is to produce harmonic current equal in magnitude but opposite in phase to those harmonics that present in grids. The phase shift of the harmonic current is 180° [19]. The ASF is connected in series in the proposed system to compensate both voltage harmonics and power factor.

IV. OPERATION OF THYRISTOR SWITCH CAPACITOR

TSC system is one of the types of shunt voltage controller. In single-phase system, TSC has minimum of two back-to-back thyristor pairs are connected in series with the reactor and capacitor, and its basic version is shown in Fig. .3. There may be more than one branch in a single phase, and it depends on the reactive power. Owing to the simple design and ease of installing, TSC is preferred for reactive power compensation. Apart from compensation, it is as supply voltage support, harmonic filtration and much more application.

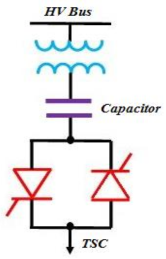

Figure 3. Thyristor-switched capacitor

TSC generates and delivers the capacitive reactive power to the electric utility grid. So, it can reduce the reactive power demanded by the inductive loads of the large industry. The switches are triggered on at an instant where the voltage across the switch and line voltages are equal. The other control techniques that support the charging of capacitors before triggering the switches for better transient response and zero crossing detectors were also utilized. There are various configurations for TSC such as thyristor-diode pairs, delta connected capacitors, star connected TSC, and much more. TSC was used for regulation of arc suppression voltage and reactive power [20]-[21]. The thyristor-switched capacitor is connected in parallel with the proposed system for the compensation of the reactive power.

V.USAGE OF SOLID-STATE CIRCUIT BREAKER

In solid state circuit breaker (SSCB), the comparator compares the voltage on the source and the signal for the comparator being coming from the current sensor. The selection of R_{TH} will decide the threshold current which will be mirrored and returned to the source by a resistor. This will set the tip voltage on the comparator. When there is a line fault, an internal current latch is set, which will switch off the power MOSFET. The control pin will be low due to the fault, and it will be high by resetting, and it has been done before MOSFET switched on again. The resistor is connected to hold the input low and possess the power MOSFET off until the clearing of fault and resetting the circuit. Simple design and low cost are the advantages of using solid state circuit breaker in power system for protecting the power electronic converter [22]-[24]. SSCB is used in this paper during fault condition and faults isolation condition.

VI. RESULTS AND DISCUSSION

A. Simulation Results & Discussions

The system with ASF and TSC is modelled and simulated using MATLAB as shown in Fig. 4. ASF is used to reduce the harmonics in the alternator. The thyristor-switched capacitor (TSC) is added to improve the voltage and transmission ability of the electric power system. The sending end voltage in kV is shown in Fig. 5. The switching pulses for M1, M3 and M5 are shown in Fig. 6.

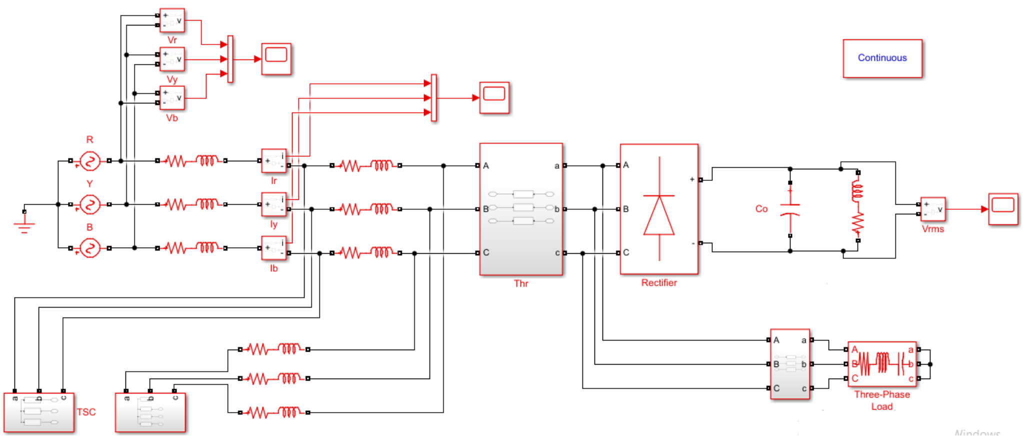

Figure 4. Circuit model of SAF and TSC

The delta connected Thyristor-switched capacitor is shown in Fig. 7. The current and the voltage waveforms at the receiving end are shown in Fig. 8 and Fig. 9 respectively. The reactive and real power at the receiving end is shown in Fig. 10 and Fig. 11 respectively. The spectrum of source current is shown in Fig. 12. THD is less than 5.4%, and it can be seen that the voltage reaches a standard value due to the addition of TSC.

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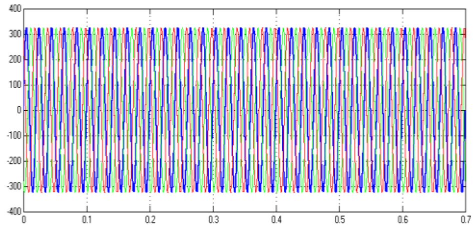

Figure 5. Sending end voltage in kV with respect to time in x-axis

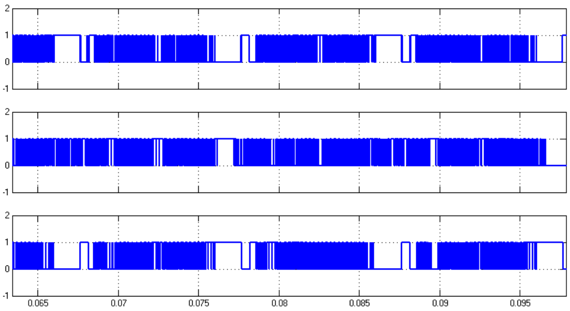

Figure 6. Switching pulse in V for (M1, M3, M5) with respect to time in x-axis

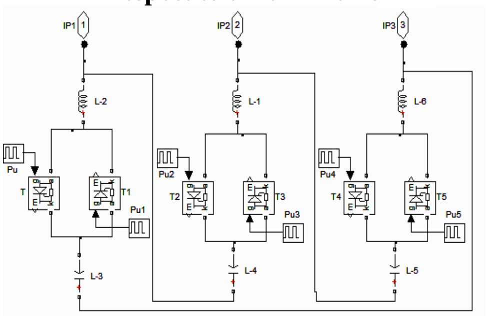

Figure 7. Matlab model of delta connected TSC

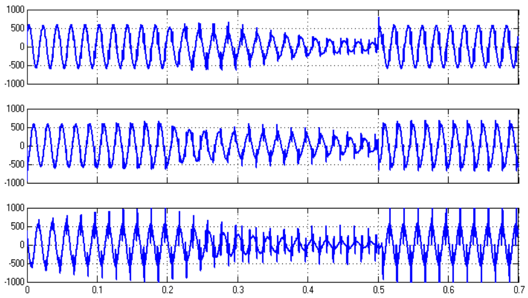

Figure 8. Output voltage of all 3 phases at the receiving end in kV

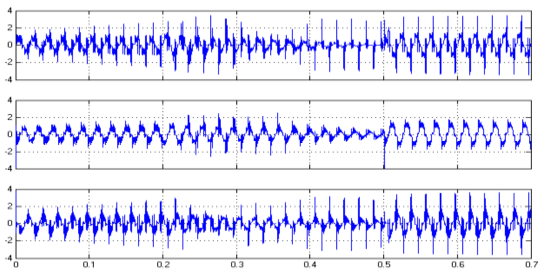

Figure 9. Output current of all 3 phases at the receiving end in kA

The output current and the voltage waveform are shown in Fig. 8 and Fig. 9. It displays that there is a line fault and there will be a distortion on line voltage, and it is cleared after some period in ms.

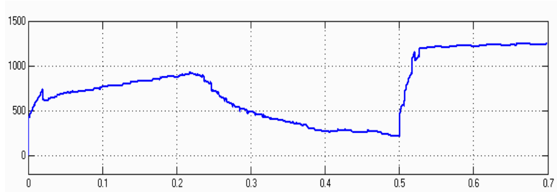

Figure 10. Real power flow at receiving end in MW

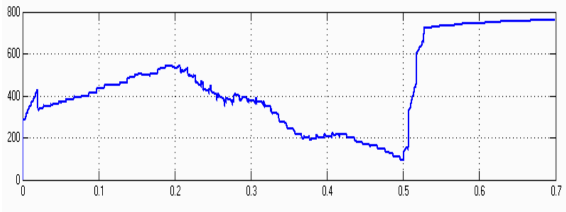

Figure 11. Reactive power flow at receiving end in MW

The real and reactive power of the Fig. 10 and Fig. 11 which shows can get the range up to the level by introducing active shunt filter and thyristor switched capacitor. The THD level will reduce and meet the power quality by an ASF as shown in Fig. 12.

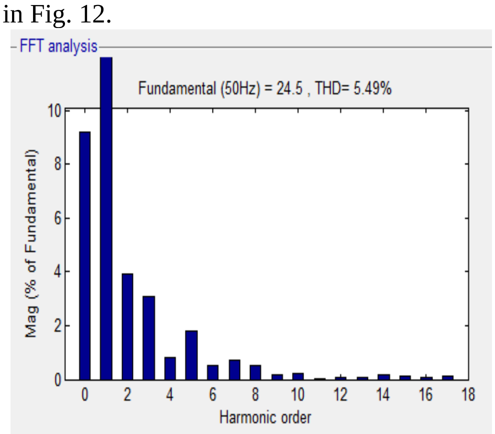

Figure 12. Spectrum for the source current

B. Simulation of Two Bus System During Fault Condition

The simulink model of two bus systems with a shunt active filter and thyristor switched capacitor during fault condition is shown in Fig. 13.

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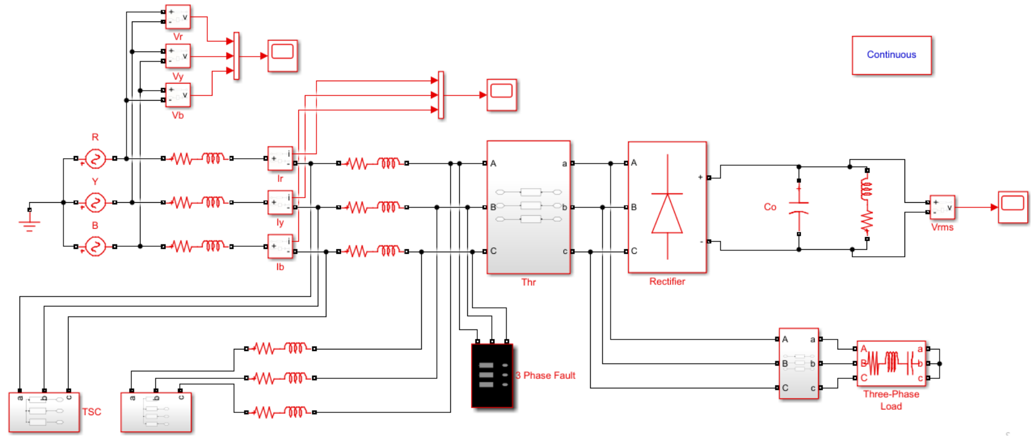

Figure 13. Matlab model of two bus systems with SAF and TSC

Sending end voltage is shown in Fig. 14. The fault condition is created at t=0.3s. The voltage reduction is as shown in Fig. 15. The load current decreases since the terminal voltage reduce to zero as shown in Fig. 16. The reactive and real power is shown in Fig. 17 and Fig. 18 respectively. The power reduction is due to the reduction in the output voltage.

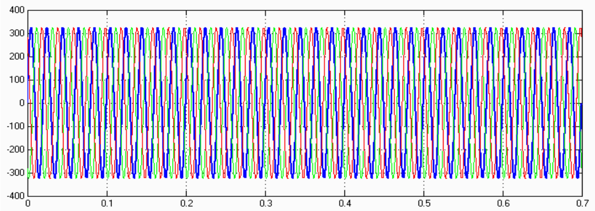

Figure 14. Sending end voltage for two bus system in kV

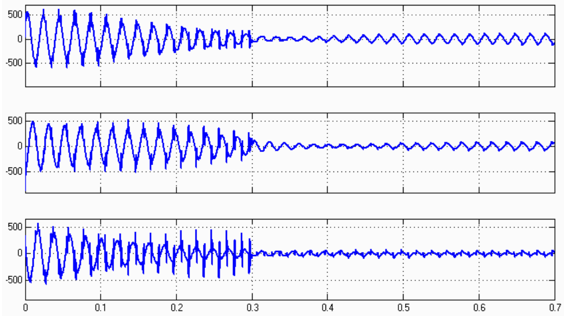

Figure 15. Output voltage in kV of all phases when fault created at 0.3sec

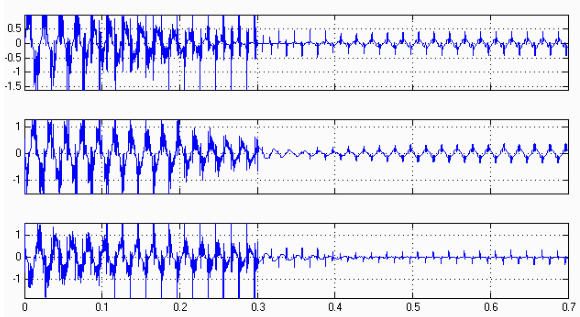

Figure 16. Output current in kA of all 3 phases when fault created at 0.3sec

Fig. 15 and Fig. 16 shows the output voltage and current at fault with distortion, and it can be reduced and can get clear instant and by power quality improvement through an ASF and TSC.

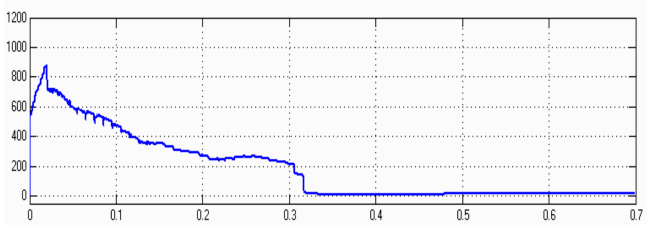

Figure 17. Real power flow in MW during fault created at 0.3sec

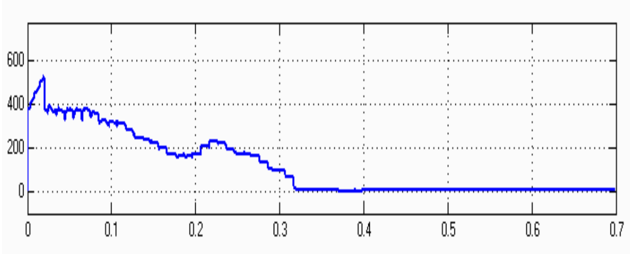

Figure 18. Reactive power flow in MW during fault created at 0.3sec

Fig. 17 and Fig.18 show that the real and reactive power at fault, performance is worst and it is evident by reducing harmonic and improving the power quality.

C. Simulation of Two Bus System with Fault Isolation Condition

The simulink model with the fault being isolated is shown in Fig. 19. The fault is isolated using a solid-state circuit breaker (SSCB). The sending end voltage is shown in Fig. 20. The system output current and voltage are shown in Fig. 21 and Fig. 22 respectively. The current and voltage resumes a normal value after the fault. The real and reactive power is shown in Fig. 23 and Fig. 24 respectively.

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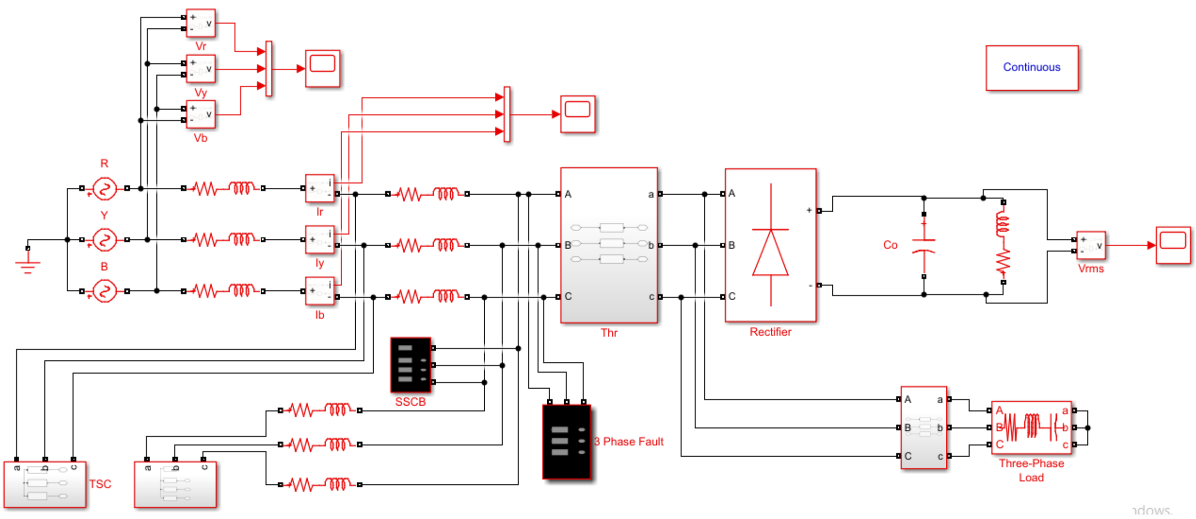

Figure 19. Matlab simulation model of two bus system with SAF and TSC during fault isolation

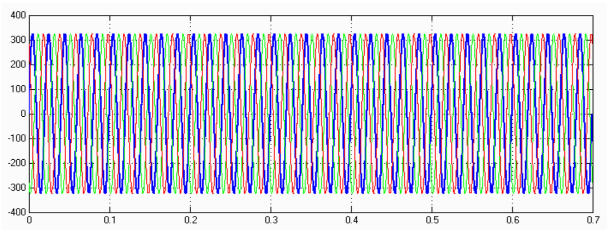

Figure 20. Sending end voltage during fault isolation in kV

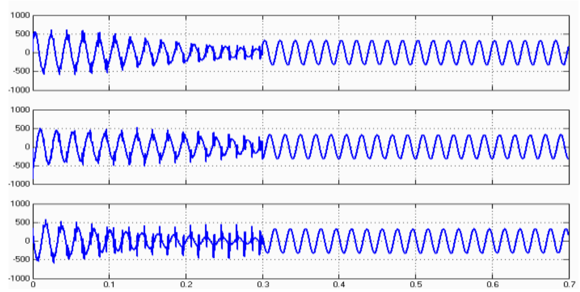

Figure 21. Output voltage in kV of all 3 phases when fault isolated at 0.3sec

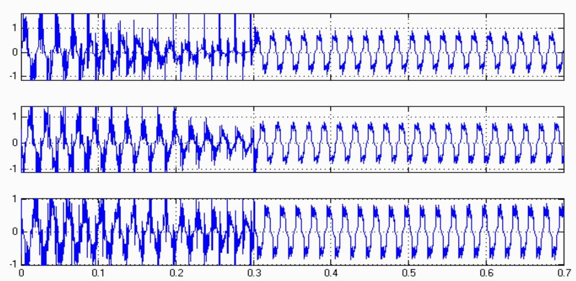

Figure. 22 Output current in kA of all 3 phases when fault isolated at 0.3sec

The Fig. 21 and Fig. 22 will show that the output voltage and current will come out of distortion and after isolating the fault, it made be a precise performance.

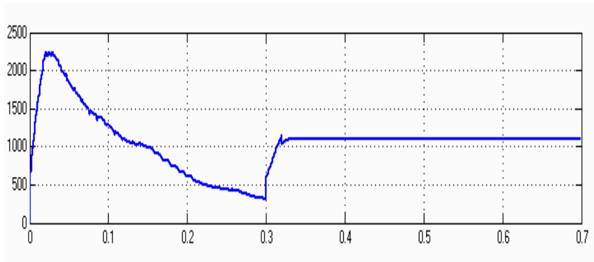

Figure 23. Real power flow in MW when fault isolated at 0.3sec

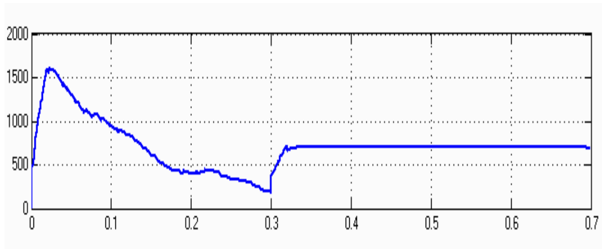

Figure 24. Reactive power in MW when fault isolation at 0.3sec

The real and reactive power at the isolated condition as shown in Fig. 23 and Fig. 24 and it explains by making a fault condition to be isolated as well as the real and reactive power will improve. The total harmonic distortion levels are shown in Fig. 25.

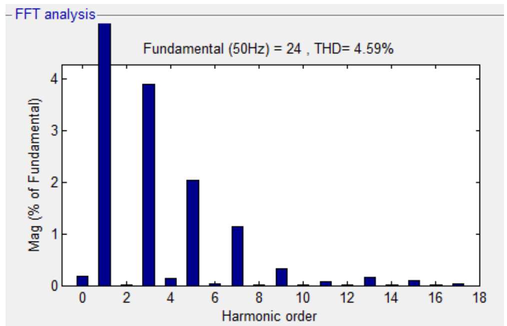

Figure 25. Spectrum for source current when fault isolation

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D. Hardware Implementation

The hardware prototype has two significant circuits, namely, a control circuit and inverter power circuit. Control circuits consist of ATMEL controller for processing and driver circuits comprising of IR2113. The driver circuit is used to drive the MOSFET switches. The driver IC accuracy is high, and it is used to amplify the pulses. The other significant circuit is a power circuit that consists of a rectifier, RL Load, RLC Load, MOSFET (switches). The rectifier converts the AC into DC. RL acts as a load at the output end. The real and reactive power consumed by the load is proportional to the square of the applied input voltage. The ATMEL controller produces the pulse to drive the MOSFET at 5V, but this voltage will not be sufficient to drive the MOSFET. Since the minimum voltage for pulse requirement is 20V; the voltage needs to be amplified to 20V as shown in Fig. 26.

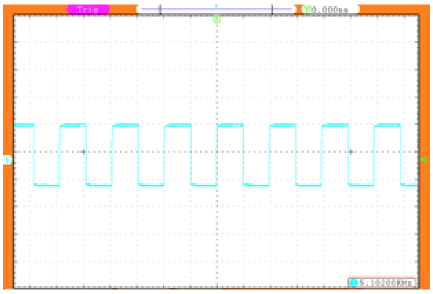

Figure 26. Switching waveform for MOSFET at 20V

The MOSFET driver IR2113 is used to amplify the switching pulse up to 20V, or more and clear pulse is shown in Fig. 26.

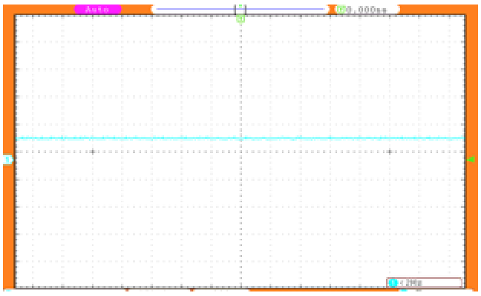

Figure 27. Output voltage in V of R-phase when the fault occurs

At fault condition, the output waveform is a straight line, and it is shown in Fig. 27. Almost the output voltage is equal to zero. After active shunt filter is used, the output voltage at fault isolation condition is shown in Fig. 28.

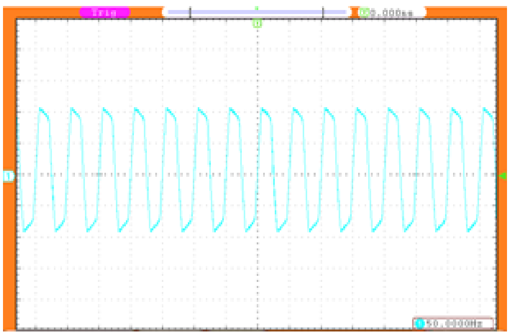

Figure 28. Output voltage in V of R-phase during fault isolation

VII. CONCLUSION

Two bus systems with FACTS devices such as shunt active filter and thyristor switched capacitor are modelled and simulated successfully. The system proposed in this paper with fault and fault isolated condition is simulated, and the results were presented. The results indicate that SSCB fetched normal condition to the isolated fault system. The advantages of this system are a reduction of heat in the alternator and improvement of receiving end voltage. The cost of the power system increases due to the addition of ASF, TSC and SSCB. In the hardware, the occurrence of a fault is isolated with the help of SSCB. However, in the laboratory, it is not possible to use a solid-state circuit breaker. The same operation is performed by three ways toggle switch, and it acts as an SSCB.

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REFERENCES

1. S. Chowdhury, SP. Chowdhury, and P. Crossley, “Microgrids and active distribution networks”, IET Renew. Ene. Series, vol. 6, pp. 230-255, 2009.
2. M. Premkumar, and TR. Sumithira, “Design and implementation of new topology for solar PV based transformerless forward microinverter”, J. Electri. and Engg. and Tech., Early Access, 2019. DOI: 10.1007/s42835-018-00036-2.
3. Y. Abdel-Rady, I. Mohamed, and Ehab F. ElSaadany, “A control scheme for PWM voltage-source distributed-generation inverters for fast load-voltage regulation and effective mitigation of unbalanced voltage disturbances”, IEEE Trans. on Indus. Electro., vol.55, no. 5, pp. 2072-2084, 2008.
4. Y. Wei Li, and J. Wei He, “Distribution system harmonic compensation methods”, IEEE Indus. Electro. Maga., vol. 8, no. 4, pp. 18-31, 2014.
5. H. Nikkhajoei, and RH. Lasseter, “Distributed generation interface to the CERTS microgrid”, IEEE Trans. on Power Del., vol. 24, no. 3, pp. 1598-1608, 2009.
6. L. Asiminoaei, R. Teodorescu, F. Blaabjerg, and U. Borup, “A digital controlled PV-inverter with grid impedance estimation for ENS detection,” IEEE Trans. on Power Electro., vol. 20, no. 6, pp. 1480-1490, 2005.
7. V. Diana, M. Sumner, and P. Zanchetta, “Non-invasive power system impedance monitoring for improved power quality,” In: Proc. of 2nd IEEE Conf. on Power Electro., Mach. and Dri., Edinburgh, pp. 265-268, April 2004.
8. RH. Lasseter, “Microgrids”, Power Engg. Soc. Winter Meet., pp. 305-308, 2002.
9. S. Bacha, D. Picault, and B. Burger, I. Etxeberria-Otadui, J. Martins, “Photovoltaics in microgrids : an overview of grid integration and energy management aspects”, IEEE Indus. Electro. Maga., vol.9, no. 1, pp. 33-46. 2015.
10. M. Sumner, A. Abusorrah, and D. Thomas, “Real-time parameter estimation for power quality control and intelligent protection of grid-connected power electronic converters,” IEEE Trans. on Smart Grid, vol.5, no.4, pp.1602-1607, 2014.
11. O. Palizban, and K. Kauhaniemi, “Hierarchical control structure in microgrids with distributed generation: Island and grid-connected mode”, Renew. and Susta. Ener. Rev., vol. 44, pp. 797-813, 2015.
12. TL. Vandoorn, JDM. De Kooning, B. Meersman, and L. Vandevelde, “Review of primary control strategies for islanded microgrids with power-electronic interfaces”, Renew. and Susta. Ener. Rev., vol. 19, pp. 613-628, 2013.

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13. F. Blaabjerg, R. Teodorescu, M. Liserre, and AV. Timbus, "Overview of control and grid synchronization for distributed power generation systems", IEEE Trans. on Indus. Electro., vol. 53, no. 5, pp. 1398-1409, 2006.
14. D. Cornforth, T. Moore, and S. Sayeef, "Challenges and opportunities for inverters in microgrids", In: Proc. of the 37th Annual Conference of IEEE Indus. Electro. Soc., Australia, pp. 3111-3116, 2011.
15. IR. Smith, and GK. Creighton, "Reactive-current compensation by switched capacitors," IEEE Trans. on Indus. Electro. and Cont. Instru., vol.22, no.1, pp. 75-78, 1975.
16. H. Ai-jun, S. Fei., and C. Wen-jin, "Zero-cross triggering technology of series SCRs with the optical fibre at medium voltage: Application for thyristor switched capacitor," In: Proc. of the IEEE/PES Trans. and Dist. Conf. and Exhi: Asia and Pacific, Dalian, China, pp. 1-5, August 2005.
17. L. Asiminoaei, R. Teodorescu, F. Blaabjerg, and U. Borup, "Implementation and test of an online embedded grid impedance estimation technique for PV inverters," IEEE Trans. on Indus. Electro., vol. 52, no. 4, pp. 1136-1144, 2005.
18. M. Sumner, B. Palethorpe, and DWP. Thomas, "Impedance measurement for improved power quality - part 2: A new technique for standalone active shunt filter control," IEEE Trans. on Power Deli., vol.19, no.3, pp. 1457-1463, 2004.
19. R. Ren and M. Kezunovic, "Real-time power system frequency and phasors estimation using recursive wavelet transform," IEEE Trans. on Power Deli., vol.26, no.3, pp. 1392-1402, 2011.
20. S. Tsukamoto, S. Ogawa, Y. Natsuda, Y. Minowa and S. Nishimura, "Advanced technology to identify harmonics characteristics and results of measuring," In Proc. of 9th IEEE Conf. on Harm. and Quality of Power, Orlando, pp. 341-346, October 2000.
21. M. Sumner, D. Thomas, A. Abusorrah, L. Yao, R. Parashar, and M. Bazargan, "Intelligent protection for embedded generation using active impedance estimation", In Proc. of 2nd IEEE Intern. Symp. on Power Electro. for Distri. Gen.. Sys., China, pp. 47-52, June 2010.
22. NA. Khan, F. Baig, S. Junaid Nawaz, N. Ur Rehman and SK. Sharma, "Analysis of power quality signals using an adaptive time-frequency distribution," Energies, vol. 933, pp. 1-13, November 2016.
23. V. Lavanya, and N. Senthil Kumar, "A review: control strategies for power quality improvement in microgrid", Inter. J. of Renew. Ener. Rese., vol.8, no.1, March 2018.
24. Ghanem, M. Rashed, M. Sumner, MA. El-sayes and III. Mansy, "Grid impedance estimation for islanding detection and adaptive control of converters," In Proc. of 8th IET Inter. Conf. on Power Electro., Mach. and Dri., Glasgow, 2016, pp. 1-6.

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