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Harmonic Conditioner for SPMC as an Inverter

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ABSTRACT: This paper proposes design and simulation of filters to minimize the power quality impact of single phase matrix converter (SPMC) as an inverter. Matrix converter has several advantages over conventional rectifier inverter type of power frequency converters. Although matrix converter injects significant current harmonics back into the system , the current harmonics can have a detrimental effect on the reliability of the plant's electrical system.

The control strategy proposed is designed such that it used to control the filter such that current harmonics is reduced. Behaviour of different filters like passive filter, active filter and hybrid filter on a matrix converter is simulated using MATLAB/SIMULINK and results are presented.

KEYWORDS: Single phase matrix converter (SPMC), Harmonics, Inverter, Active filter, Passive filter, hybrid filter, Total harmonic distortion (THD).

I.INTRODUCTION

Electrical energy is the most efficient and popular form of energy. We live in a fast and constantly evolving society where life cannot be imagined without the supply of electricity. At the same time for the efficient functioning of an electrical equipment, the quality of the power supplied is very important. Power quality disturbance is commonly defined as any change in frequency, power, voltage or current that interferes with the normal operation of the electrical equipment. Due to this discontinuity in the supply, harmonics are present. These harmonics are a frequent cause of power quality problems.

II.FILTERS

In order to maintain the quality of the power, harmonics should be filtered out. For this purpose harmonic conditioner such as 'filter' is used. There are different filter topologies present. At first passive filters are used but they are dependent heavily on the system parameters. They also have a problem of resonance with system impedance and are suitable for filtering out a particular frequency harmonics. Therefore to overcome the problems of passive filter, active filters are used. Active filters are facing some drawbacks when employed for power quality improvement. They have high converter ratings, costlier compared to passive filter, huge size and increased losses. Therefore to overcome these drawbacks a hybrid filter which is a combination of active and passive filter is used.

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III.SINGLE PHASE MATRIX CONVERTER

SPMC is an array of four bidirectional switches as the main power elements which directly interconnects the input to the load without using any DC links. It is also called a direct energy converter.

Figure 1 shows a basic block diagram of a Matrix converter

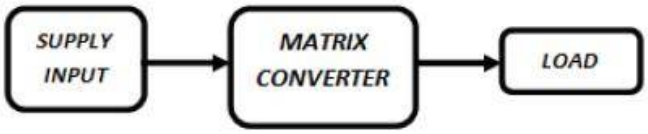

Figure 1 Block Diagram of a Matrix Converter

SPMC has many advantages compared to conventional power frequency converters such as its high dynamic current consumption, operation in all four quadrants, high efficiency and minimal storage requirements. One of the main disadvantage of SPMC is that it is a source of harmonics. SPMC can be used as a rectifier, inverter, chopper and cycloconverter.

In this paper, we are using SPMC as an inverter. Inverter converts a DC voltage or current to AC voltage or current. The input for an inverter operation is DC. For first half cycle switches S1a and S4a will conduct. For the second half cycle switches S2a and S3a will conduct as shown in Figure 2.

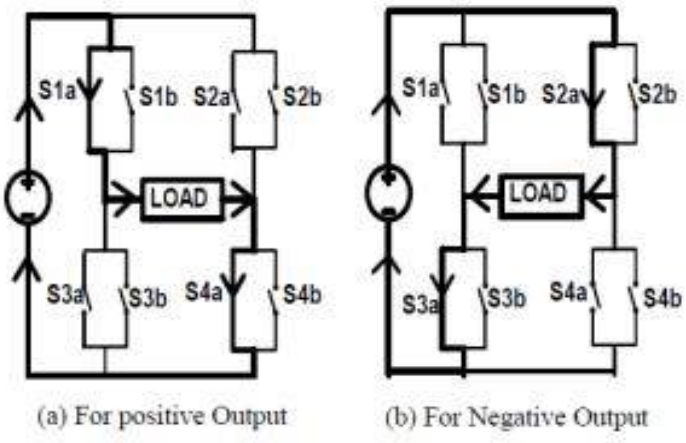

Figure 2 SPMC as an Inverter

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IV.SOFTWARE IMPLEMENTATION

A. SPMC AS AN INVERTER WITH R LOAD:

The MATLAB/Simulink model of SPMC as an Inverter with R load is as shown in Figure 3. The input to the inverter is a DC source of 240V.

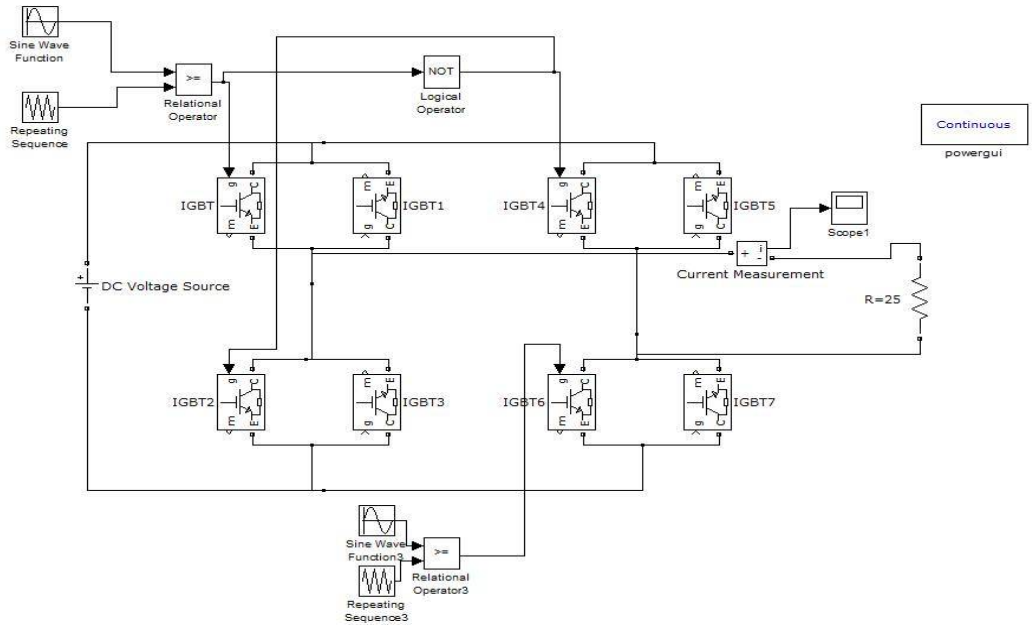

Figure 3 Simulink Model for SPMC

Figure 4 shows the Output current of SPMC as Inverter versus time, the amplitude of the current is 9.8A.

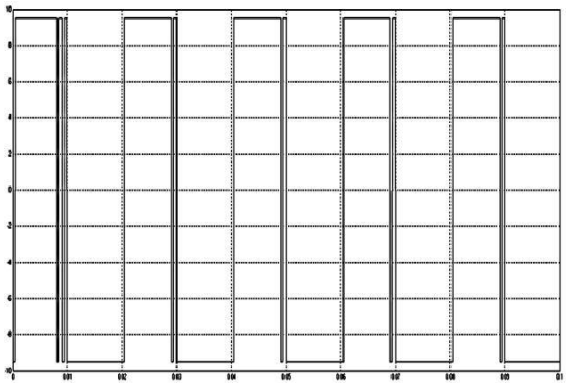

Figure 4 Output current waveform of Inverter

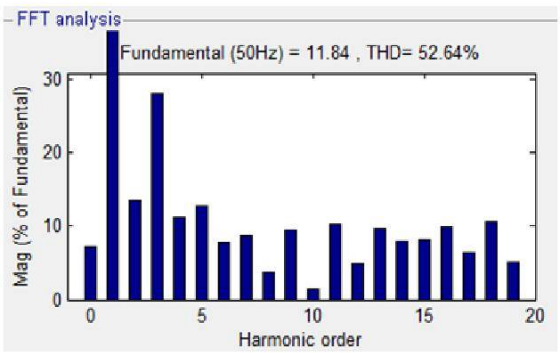

Figure 5 THD of Inverter

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The Total Harmonic Distortion is found for the Output current waveform of SPMC as Inverter by FFT Analysis. Figure 5 shows the total harmonic distortion of the circuit and it is 52.64%.

B. SPMC AS AN INVERTER WITH PASSIVE FILTER:

The MATLAB/Simulink model of SPMC as an Inverter with Passive filter is as shown Figure 6.

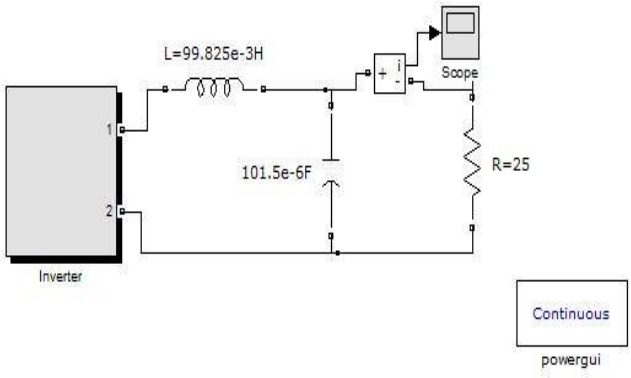

Figure 6 Simulink model of Inverter with passive filter

Figure 7 shows the Output current of SPMC as Inverter with passive filter versus time.

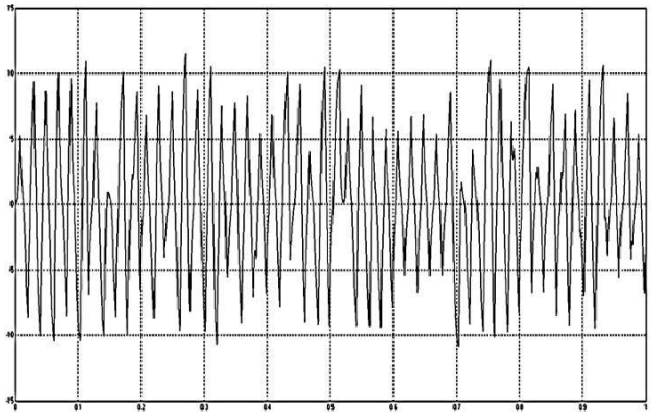

Figure 7 Output current of Inverter with Passive filter

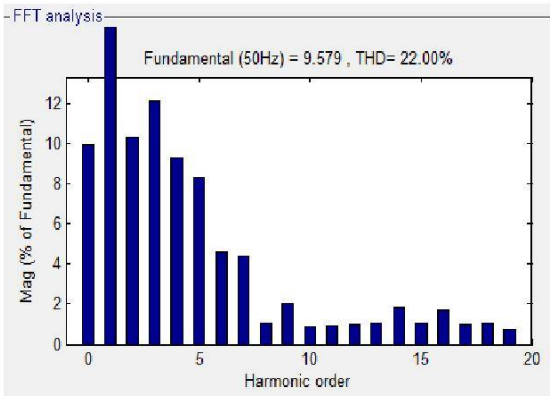

Figure 8 THD of Inverter with Passive filter

The Total Harmonic Distortion is found for the Output current waveform of SPMC as Inverter with Passive filter by FFT Analysis. Figure 8 shows the total harmonic distortion of the circuit and it is 22.00%.

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C. SPMC AS AN INVERTER WITH ACTIVE FILTER

The MATLAB/Simulink model of SPMC as Inverter with Active Filter is as shown in Figure 9.

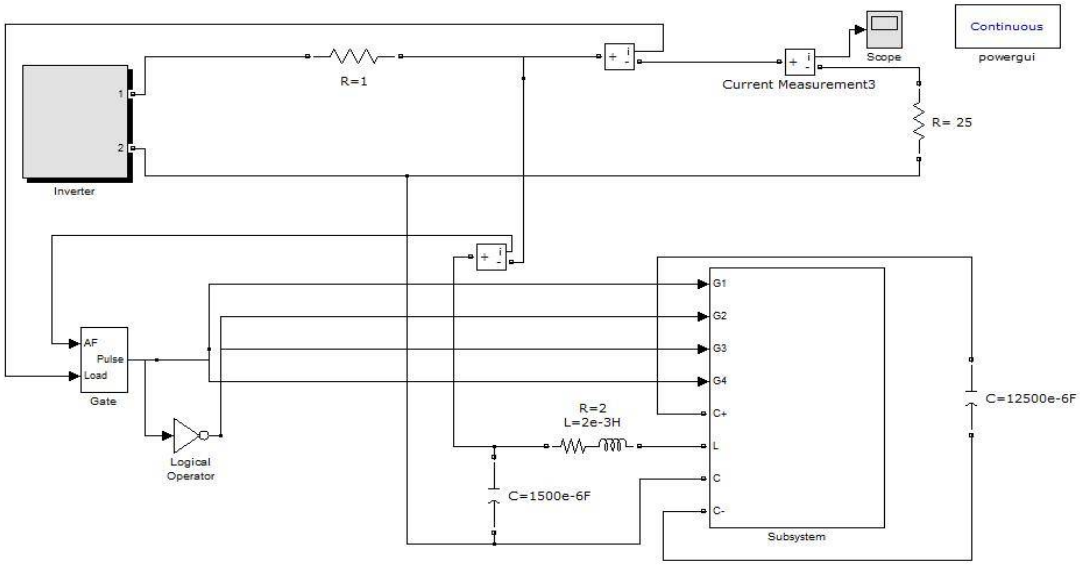

Figure 9 Simulink model of Inverter with active filter

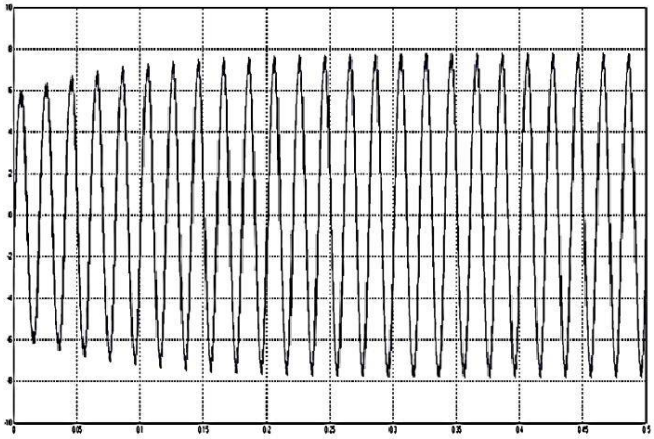

Figure 10 Output current waveform of inverter with active filter

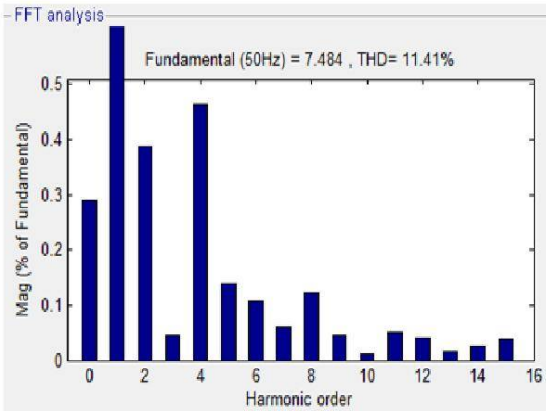

Figure 11 THD of Inverter with Active filter

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The Total Harmonic Distortion is found for the Output current waveform of SPMC as Inverter with Active filter by FFT Analysis. Figure 11 shows the total harmonic distortion of the circuit and it is 11.41%.

D. SPMC AS AN INVERTER WITH HYBRID FILTER:

The MATLAB/Simulink model of SPMC as Inverter with Hybrid Filter is as shown in Figure 12.

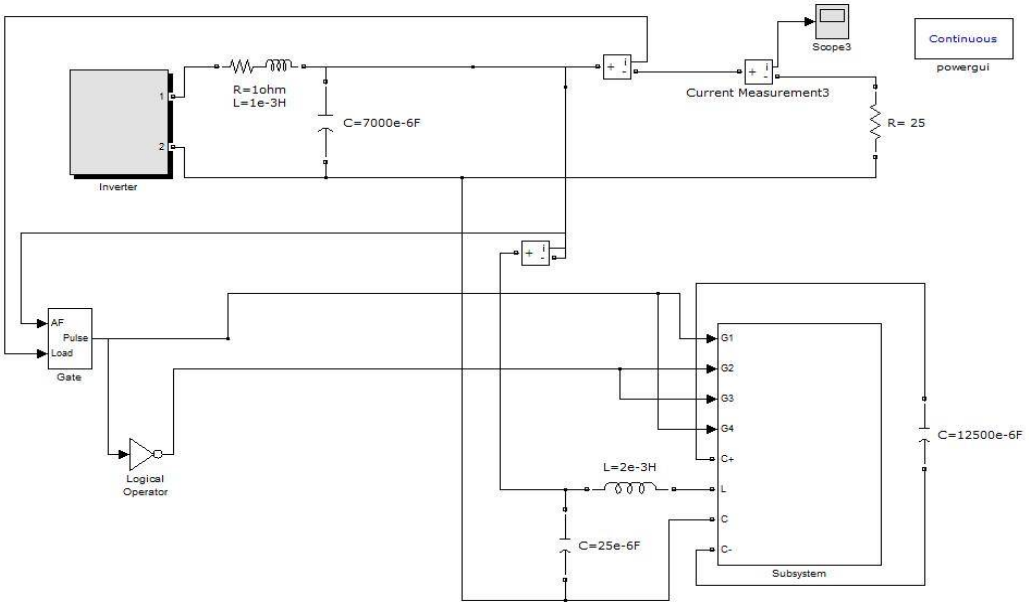

Figure 12 Simulink model of Inverter with Hybrid filter

Figure 13 shows the Output current of SPMC as Inverter with Hybrid filter versus time.

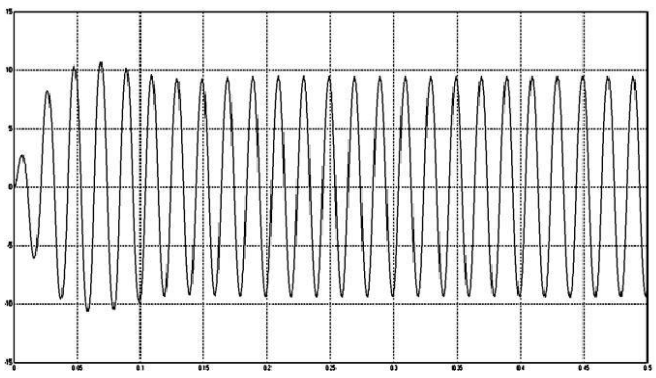

Figure 13 Output current waveform of inverter with active filter

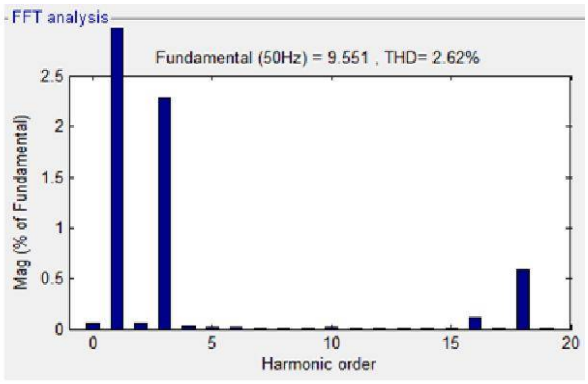

Figure 14 THD of Inverter with hybrid filter

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The Total Harmonic Distortion is found for the Output current waveform of SPMC as Inverter with Hybrid filter by FFT Analysis. Figure 14 shows the total harmonic distortion of the circuit and it is 2.62%.

V. RESULT

TYPE OF FILTER	INVERTER
NO FILTER	52.64%
PASSIVE FILTER	22.00%
ACTIVE FILTER	11.41%
HYBRID FILTER	2.62%

Matrix Converter as a Rectifier and Inverter was simulated without any filter, with passive, active and hybrid filters. The total harmonic distortion found in each of the circuit is as shown in the above table.

VI.CONCLUSION

The single phase matrix converter can be analyzed for different power electronic converter circuits using appropriate switching devices. In this case IGBT switches are used. The matrix converter as an inverter is being implemented . An inverter converts DC to AC , during this process harmonics are induced by the matrix converter. Therefore the output of the matrix converter is not purely sinusoidal in nature.

The use of filters reduces the harmonics of the matrix converter. Active, passive and hybrid filters are designed to reduce these harmonics. The designed model is implemented in a MATLAB/SIMULINK and the results are tabulated. The output waveforms are analyzed and the simulated results were compared and it was found that the hybrid filter was the most efficient filter compared to the other filters.

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