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Fault Detection of PV Fed DC Converter Fed Induction Motor System

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Abstract—*The Photo voltaic (PV) technology has a small impact on the environment and is suitable far a wide range of applications. The main barrier for a more extensive implementation has been the reliability, mainly related to the power converters. This paper presents an open-circuit, short-circuit and single-line to ground fault diagnosis and fault-tolerant scheme for a three-phase converter in a PV power system using batteries as storage devices. The result shows the comparison of the different faults. The future work includes providing optimal solution for the diagnose faults.*

1. INTRODUCTION

Due to environmental concerns and related to an energy economy based problems it is necessary to introduce renewable energies on different applications. The renewable is naturally replenishing and pollution free energy source and has different features.

Photovoltaic (PV) energy and its applications are different from the another renewable energy sources such as (wind, hydro, and geothermal energies are not available for the small applications) and suitable for all the climates and not need to maintenance. Due to all these reasons PV system is used as an alternative power solution for a variety of end uses.

There are three types of PV system grid connected, standalone, And hybrid PV system. They have specific applications. PV systems are most commonly used to connect electric power produced from the PV cells to the grid.

1.1 Solar Cell

Solar cell is a device which converts solar energy into the electrical energy. Silicon PV cell is proposed for a thin wafer consisting of an ultra-thin layer of phosphorus-doped (N-type) silicon on top of a thicker layer of boron-doped (P-type) silicon. An electrical field is created near the top surface of the cell where these two materials are in contact, called the PN junction. When sunlight strikes the surface of a PV cell, this electrical field provides momentum and direction to light, resulting in a flow of current when the solar cell is connected to an electrical load. Regardless of size, a typical silicon PV cell produces about 0.5-0.6 volt DC under open circuit, no-load conditions. The current (and power) output of a PV cell depends on its efficiency and size (surface area), and is proportional to the intensity of sunlight striking the surface of the cell.

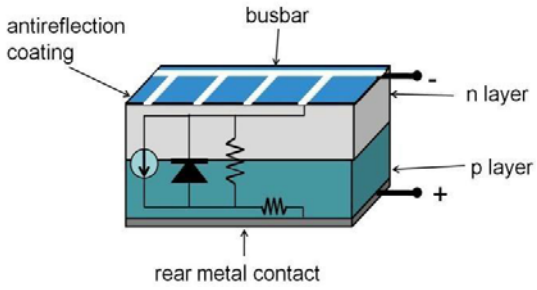

Fig. 1: Solar cell

2. MATHEMATICAL MUDDLING FOR SOLAR CELL

The efficiency of the solar module can be calculated from the equation.

$$I = Iph - Isat\left(e^{\frac{V+IRs}{NsAVT}} - 1\right) + \frac{V+IR\,s}{Rp} \quad (1)$$

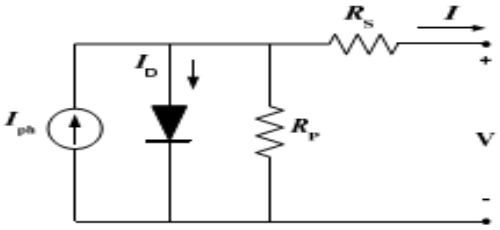

Fig. 2: Circuit of solar cell

1.2. DC to AC converter (inverter)

We use three phase full bridge inverter in this paper. It converts DC power into AC power at desired output voltage. The three phase full bridge inverters topology is shown in fig. three phase converts are used where transformation is between DC and AC voltage required.

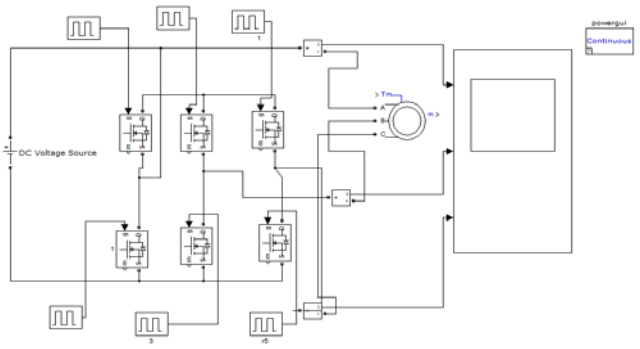

Fig. 3: Simulation circuit of inverter

1.3. AC to DC Converter(Rectifier)

AC to DC converter is a converter which converts the AC supply into DC supply. When the MOSFET switch is ON, the current through the inductor increases and the inductor starts to store energy. When the MOSFET switch is closed, the energy stored in the inductor starts dissipating.

The Voltage across the load is greater than the input voltage and is dependent on the rate of change of the inductor current. Thus the average voltage across the load is greater than the input voltage and is determined with help of the duty cycle of the gate pulse to the MOSFET switch . The schematic diagram for the boost converter used in this research work to step up the PV output voltage to a higher level suitable for the DC/AC inverter operation that connected to the utility grid.

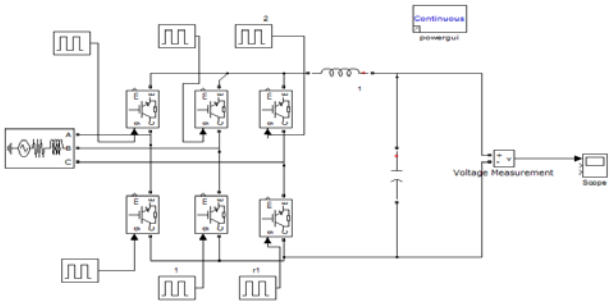

Fig. 4: Simulation circuit of converter

3. METHODOLOGY

Modeling and simulation of dc source fed induction motor drive and conventional PV source fed induction motor drive are investigated here.

Table 1: Parameters of proposed work.

Parameters	Value	Unit
Input voltage	150	V
PV source parameter		
s/c current	24	Amp
o/c current	150	V
output current	4*10	Amp
3 phase induction motor parameters	400 1.405 0.005 1.395 0.005	V Oh
Stator resistance	0.1722	M
Stator inductance		H
Rotor resistance		Oh
Rotor inductance		H
Mutual inductance		
Output Current (I_0)	$4*10^{-13}$	Amp
Output voltage (V_o)	$3*10^{-11}$	V

1(a) Simulation circuit of three phase converter and inverter with induction motor

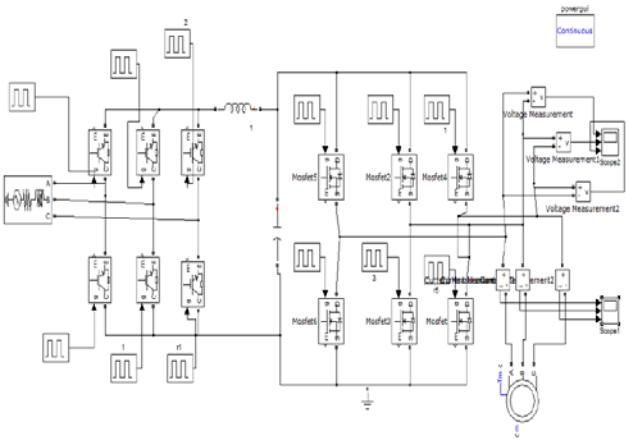

Fig. 6: Simulation circuit of proposed work

1(b) Output wave form of proposed work

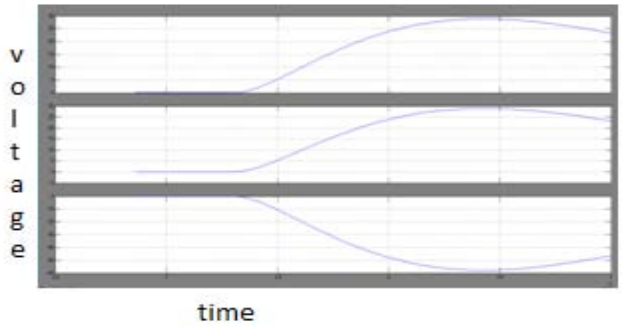

Fig. 7: Output voltage

2(a) Simulation circuit of line to ground fault

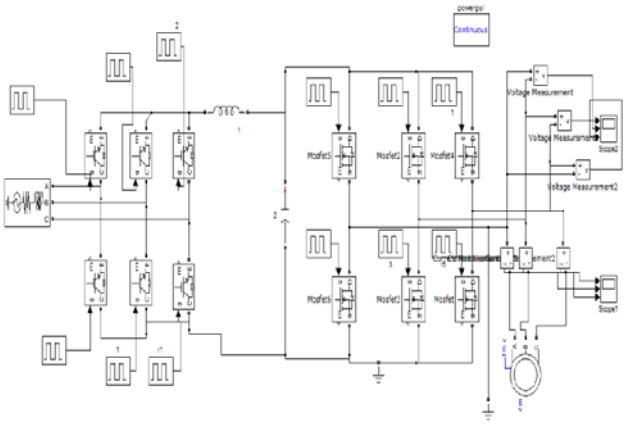

Fig. 8: Simulation circuit of line to ground fault

2(b) Wave form of line to ground fault

Fig. 9: Output of current of line to ground fault

3(a) Simulation circuit of short circuit fault

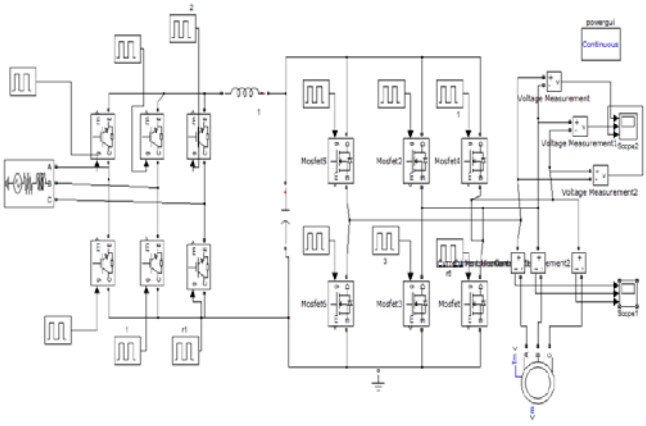

Fig. 10: Simulation circuit of short circuit fault

3(b) Wave form of short circuit fault

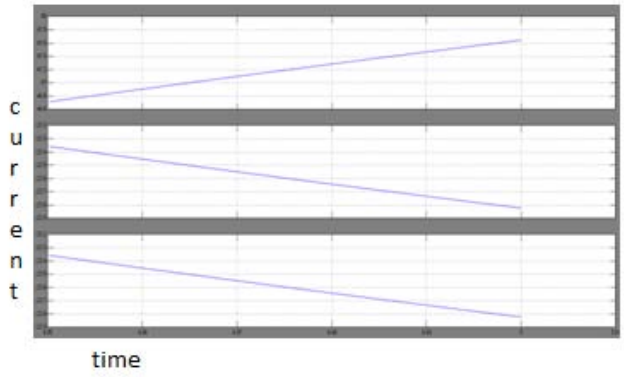

Fig. 11: Output current of short circuit fault

4(a) Simulation circuit of open circuit fault

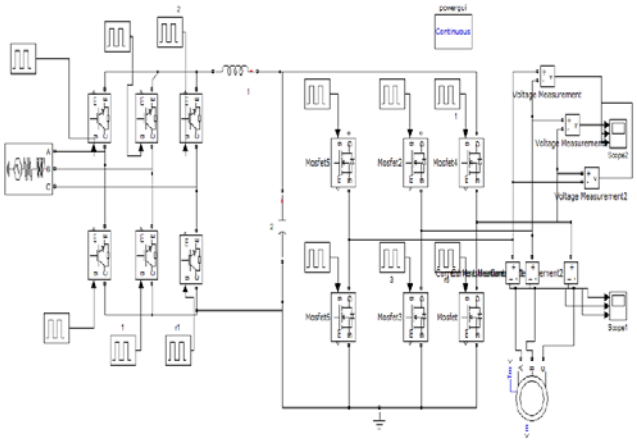

Fig. 12: Simulation circuit of open circuit fault

4(b) Wave form of open circuit fault

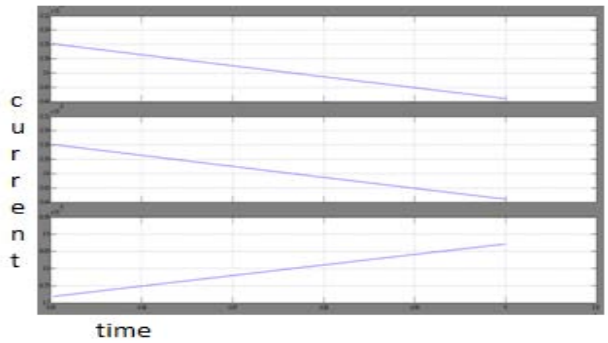

Fig. 13: Output current of open circuit fault

5(a) Simulation circuit of PV fed induction motor drive

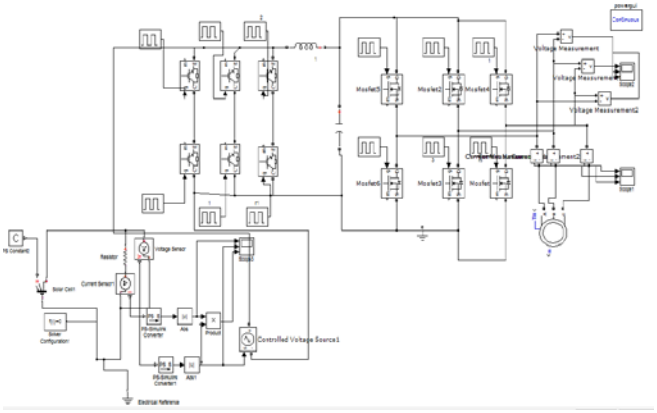

Fig. 14: Simulation circuit of PV fed converter and inverter circuit

5(b) Output of PV fed converter and inverter circuit

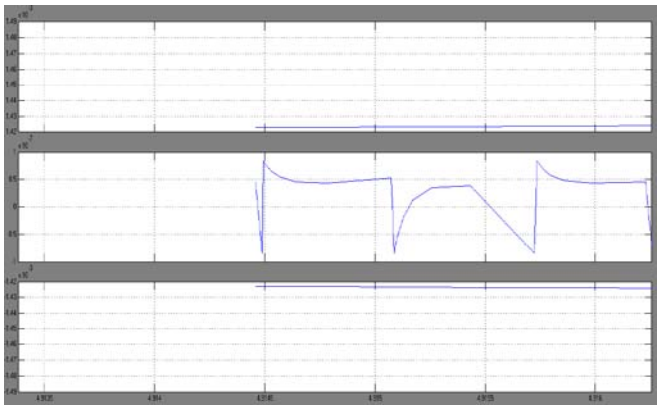

Fig. 15: Output current of PV fed converter and inverter circuit

6(a) Simulation circuit of PV fed line to ground fault

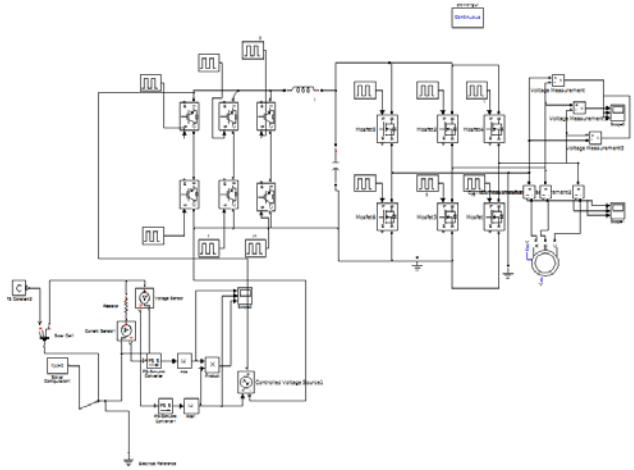

Fig. 16: Simulation circuit of PV fed line to ground fault

6(b) Output current of PV fed line to ground fault

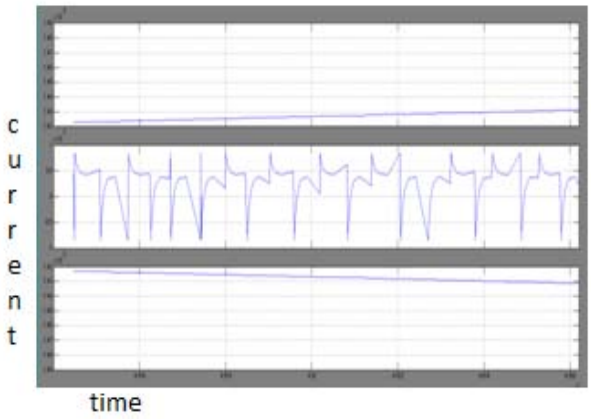

Fig. 17: Output current of PV fed line to ground fault

7(a) Simulation circuit of PV fed short circuit fault

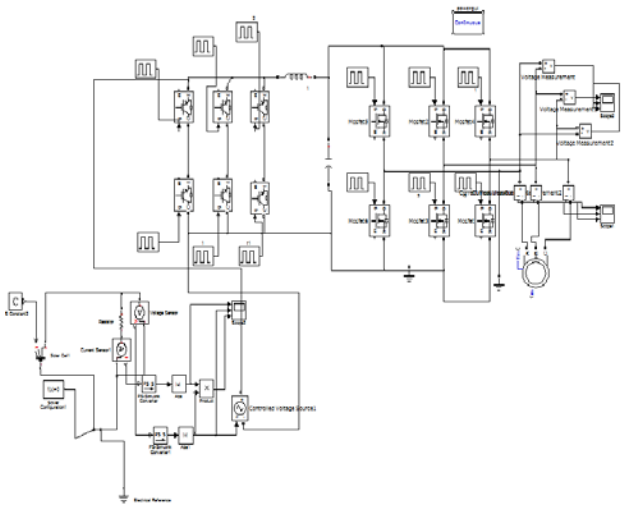

Fig. 18: Simulation circuit of PV fed short circuit fault

7(b) Output of PV fed short circuit fault

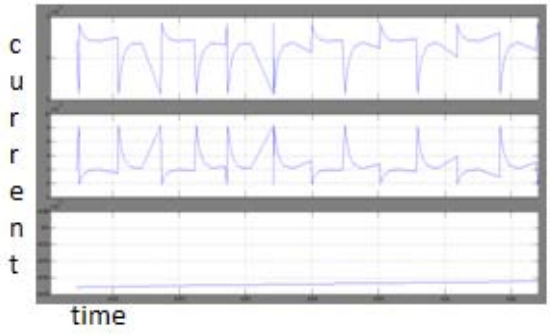

Fig. 19: Output current of PV fed short circuit fault

8(a) Simulation circuit of PV fed open circuit fault

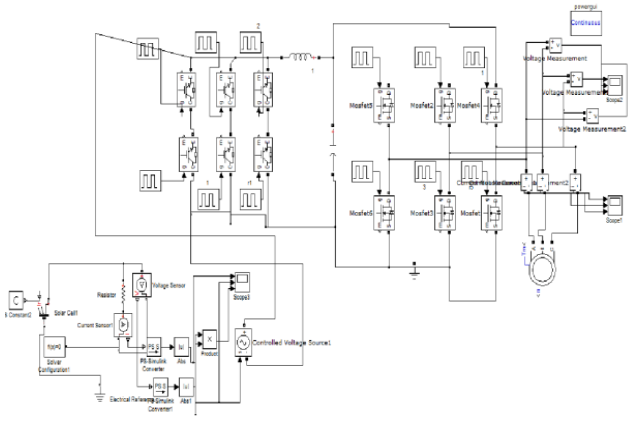

Fig. 20: Simulation circuit of PV fed open circuit fault

8(b) Output current of PV fed open circuit fault

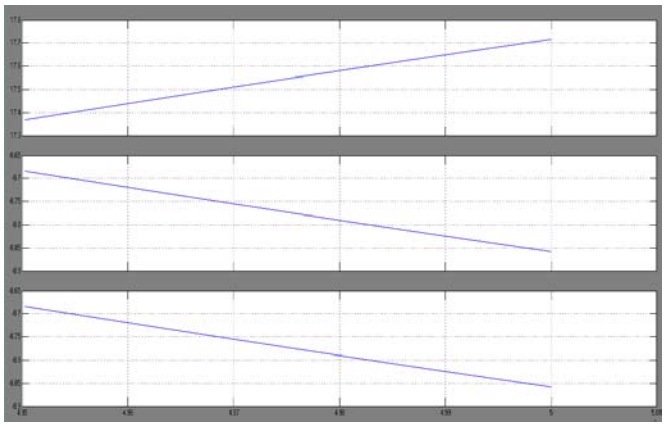

Fig. 21: Output current of PV fed open circuit fault

4. RESULT

When 150V input the output is 15A in normal circuit and $1*10^{-7}$A. In the case of open circuit fault the output is -$1.25*10^{-9}$A in nrmal circuit and $3.5*10^{-4}$A in PV fed circuit.In the case of short circuit fault the output is 17.4A and $4*10^{-3}$A in PV fed circuit.In the case of line to ground fault the output is5.1A and $1.49*10^{-7}$A in PV fed circuit.

Table 2: Comparison of simulation results.

Voltage	Without fault	Open circuit fault	Short circuit fault	Line to ground fault
150V				
Current(amp)	15	$-1.25*10^{-9}$	17.4	5.1
PV fed circuit Current(amp)	$1*10^{-7}$	$3.5*10^{-4}$	$4*10^{-3}$	$1.49*10^{-7}$

5. CONCLUSION

Converters and inverters are most wildly used in different areas as house holding and industrial uses also. In many cases they used in embedded system also. In project we analysed the comparative the different faults (open circuit fault, short circuit fault, line to ground fault). Thus we saw all types of faults are less in PV fed circuit compared to the normal circuit.

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