International Journal of Power Electronics and Drive System (IJPEDS)
Vol. 7, No. 4, December 2016, pp. 1193~1199
ISSN: 2088-8694, DOI: 10.11591/ijpeds.v7i4.pp1193-1199

Battery-equivalent DC Supply from Leakage Current: PV to Transformer-less Inverter Topology

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Article Info

Article history:

Received Apr 17, 2016
Revised Nov 7, 2016
Accepted Nov 19, 2016

Keyword:

Converter
Leakage current (LC)
Photovoltaic (PV) panel
Rectifier
Summer circuit

ABSTRACT

Solar panels are highly used for electricity generation, which can be gotten through switching-based transformer-less inverters. Hence, grid system with no galvanic-isolation, is taking the peak level in the world, which is effective and delivers power with enhanced efficiency. The PV generation presented here is for stand-alone system installed in remote areas on when and as the resulting power gets connected to electronic load installation instead of being tied to the grid. In this paper will be discussed the use of leakage current. Transformer-less inverter topology for exploring the issue of common mode (CMV) voltage development, which can be utilized as a Battery-Equivalent DC Supply after adding on places as when found suitable for such installations.

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1. INTRODUCTION

Solar panel is the combinations of many solar cells where the most important part is silicon solar cells which never run out. Generally, it gets energy from the rays of sunlight (photons) and earth radiations that come from sun light which is protect out body from ultra violet (UV) that actually harmful and affected human body. Now-a-days, solar cells set up in roof top that has household applications and hot water system. In Malaysia Perspective, maximum energy is used in industrial purposes around 43.4% in 2009 and although Malaysian will produce 190 megawatt power within 2020, but they were predicted that they will be produced 18700 megawatt power within 2050 through solar energy. In addition, this energy will be the more producible and effective energy within few years [1]. Moreover, government support is increased enormously day by day in Australia for using solar panel for household applications [2].

Solar panels are also known as modules that actually contain with photovoltaic panel which is made from silicon and in addition it transforms electricity from the sunlight rather than heat [3-5]. In historical point of view, PV panel first discovered by France scientist Edmond Becquerel in 1939 and after 15 years the American scientists Daryl Chapin, Calvin Fuller, and Gerald Pearson were developed the silicon photovoltaic (PV) cell. Hence, it has been developing until now with facing various problems and achieving huge success. In addition, Photovoltaic (PV) is becoming more popular in worldwide within few decades due to less expensive. To do so, Building Integrated Photovoltaic (BIPV) is used to reduce the manufacturing cost which is more applicable for urban areas [6]. Moreover, photovoltaic (PV) panels are helped to reduce the cost for government provided power electric supply as well which is actually very economical for industrial purposes [7-8] and the implementations of using photovoltaic panel in the case of economical benefits for long term energy planning view [9].

The Photovoltaic panels (PV) make up serious contenders to wind-energy for electric generation through grid-connectivity. In addition, its importance going up due to affordable costs as well as an effective and pollution free technique for renewable energy generation [10-12]. In order to use photovoltaic panel for charging small to big electronic devices such as laptop, mobile phone charger for a longer battery lifetime, however the leakage current is the main issue of concern [13]. Recently reported is very useful work on minimizing the power losses and cost of grid-tied solar system [14-17]. Although small in magnitude, but the leakage current occurring at different points of the panels have become more (or less) the reason of reducing power efficiency. Efforts to this effect are already underway, particularly, for traction application in a transformer-less rectifier configuration of a DC voltage controlled by fluctuating AC signal [18] to do the front-end rectification which is based on Pulse Width- Modulation buck rectifier. However, in [19], shows and discussed the two very important and useful rectifier circuits which are fully cross coupled and gate cross coupled using MOSFET based switches.

In this paper has been shown the different leakage paths which are occurred in various places in the PV-Transformer-less inverter system. These leakage currents are adding through the summer circuit and after doing some steps, its possible to achieve around 1V DC.

2. BLOCK DIAGRAM OF OVERALL TECHNIQUE

Transformer-less inverter topology is widely efficient for electrification purposes which is very convenient transfer of electric power onto the grid with high efficiency. In Figure 1 has been shown the block diagram that shows the overall working procedure where full bridge condition is used with the switching devices. Moreover, as an input, here uses 12V which is one solar cell. Moreover, here is used DC/DC converter for fixed up the DC that actually converter by TRX-less inverter topology and achieving AC signal can be smooth by filters. In the overall system, the LC is occurred in different placed that can be summarize by adder circuit. After that used rectifiers either Fully cross coupled (FCC) or gate cross coupled (GCC) rectifiers which can be amplified by amplifier.

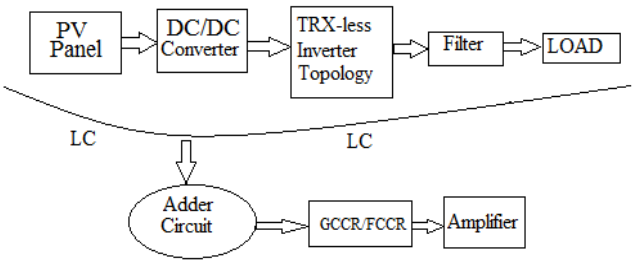

Figure 1. A Circuit Schematic of Over All Working Technique

In Figure 2(a) is shown the High Order Low Pass Filter (HOLPF) with 10 ohm resistance and 1mf capacitance where the applying input is 1V. However, in Figure 2(b) is shown the third order Low Pass Filter used for converting Square to Sine wave with its output.

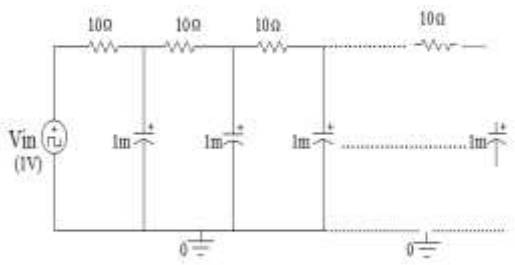

Figure 2(a). High orders Passive Low Pass Filter (HOLPF)

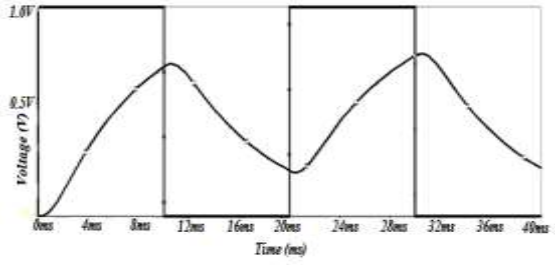

Figure 2(b). wave shape of High orders Passive Low Pass

3. SIMULATION TECHNIQUE OF LEAKAGE CURRENT

In Figures 3(a), 3(b) are shown the leakage currents when switches are in ON condition while another path shows low on current .meanwhile, the Figure 3(a) shows zero current in the time of switching off time, but Figure 3(b) shows very amount of current in the time of switching off.

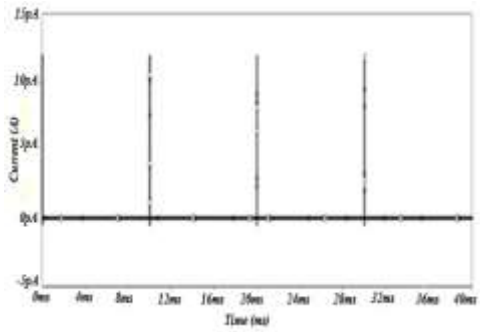

Figure 3(a). Leakage Current of an Inverter side as showing LP_2

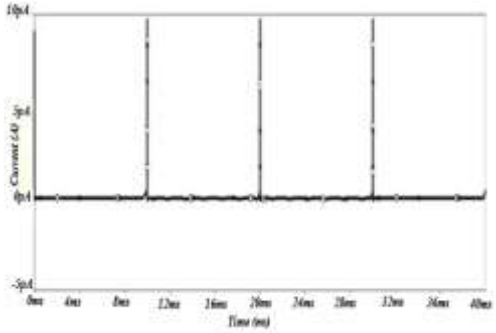

Figure 3(b). Leakage Current of an Inverter side as showing LP_4

The leakage issue also occurred in between PV panel sides in Figure 3(c) where the current can be seen as like as the inverter. Moreover, the amount of the current is remained Pico range. Figure 3(d), Figure 3(e) are

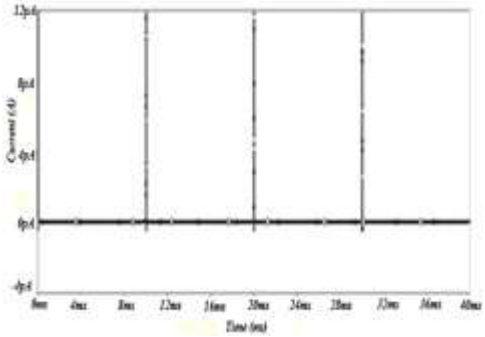

Figure 3(c). Leakage Current of the PV Panel side that shown in LP_3

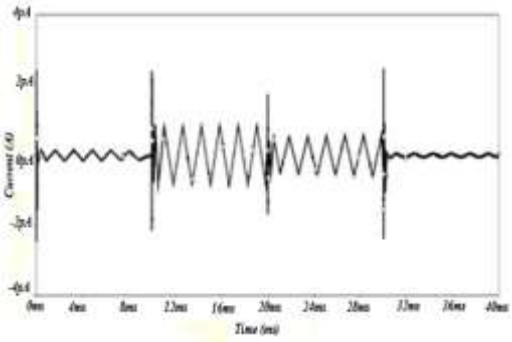

Figure 3(d). Leakage Current between Switches S1, S2, and ground

The flowing leakage current between switches S1, S2 and S1, S4 respectively. These two leakage paths are the flowing leakage current only for different switches' condition. Moreover, the wave shape for these two paths are shown approximately as like fluctuated sine wave in different magnitude where the values are very small. In addition, the leakage paths are also shown on two sides of transformer less components in Figure 3(f), Figure 3(g). These two paths are actually infected by much fluctuated current in pico Ampere (pA) range.

Other two leakage issues occur correspondingly from the load to ground as shown in Figure 3(h). This current is too very much negligible where the current flows on both sides in less than Femto range on the other hand before using low pass filter the current wave shape is shown same like sine wave where it fluctuates in some portion. Furthermore, the range of flowing current is also very negligible which is shown in Figure 3(i).

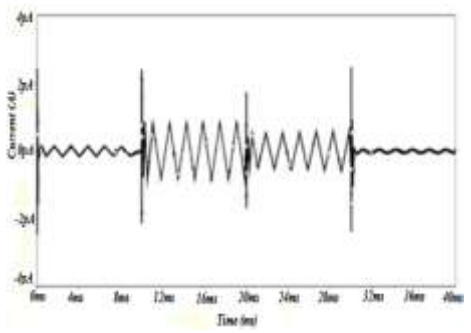

Figure 3(e). Leakage Current between Switches S3, S4 and ground

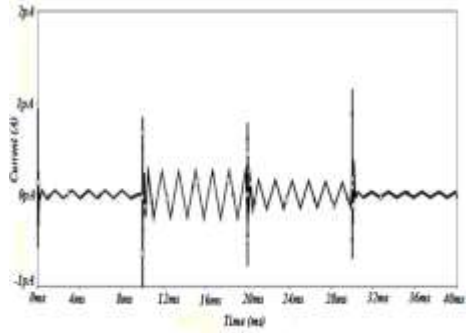

Figure 3(f). Leakage Current between one Side of transformer-less Topology and ground

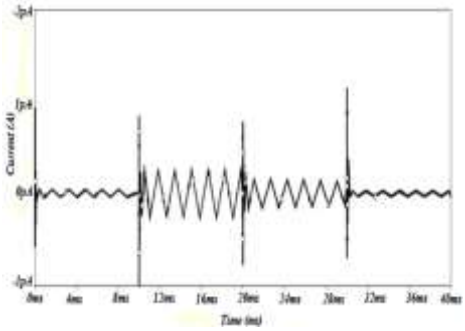

Figure 3(g). Leakage Current between another side of transformer-less Topology and ground

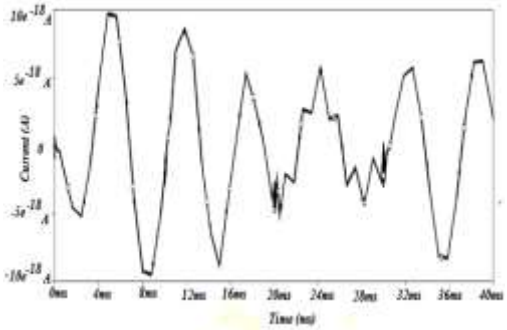

Figure 3(h). Leakage Current between the Load and ground

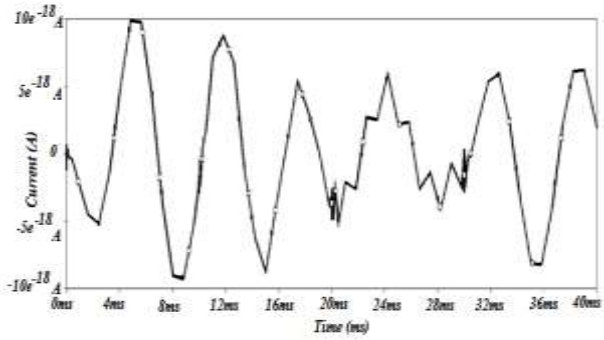

Figure 3(i). Leakage Current between High Orders LPF and ground

4. RESULT AND DISCUSSION

In below shows the different paths of occurring leakage current and the simulated wave shapes and in Figure 4 shows the adder circuit where uses for adding the leakage currents. Figure 5 (a) is actually a rectifier circuit, which is called fully cross coupled rectifier [18]. It gives very good output when we applied a sine wave of amplitude 1V input with achieving output around 1v for one cycle, however, this amplitude is reduced for another cycle that shown in Figure 6(b).

Figure 6(a) is gate cross-coupled rectifier also reported in [18]. It too gives an output when the applying an input of 1V amplitude and the achieving output an output around 600mV as shown in Figure 5(b). Moreover, here the output shows for one cycle and another cycle remain zero voltage. Figure of overall voltage for leakage paths after adding nine paths of leakage current as shown in Figure 7.

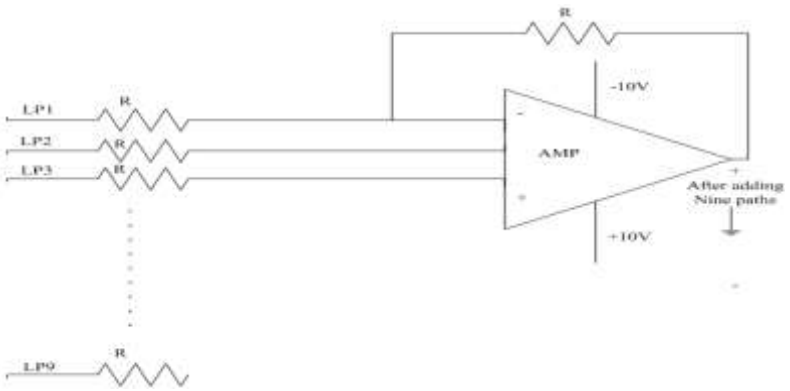

Figure 4. Summer Circuit for adding nine path currents

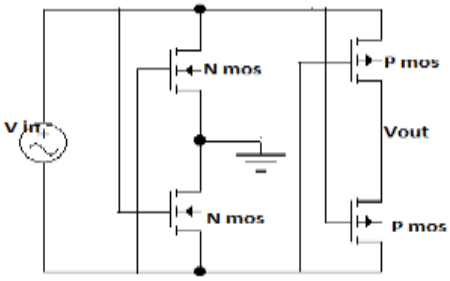

Figure 5(a). Fully cross Coupled Rectifier (FCCR)

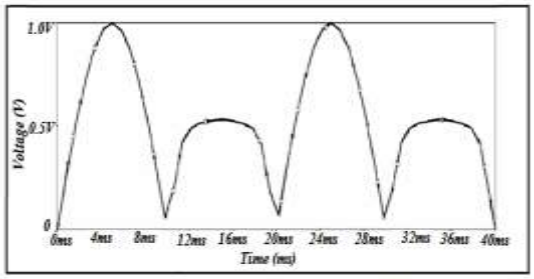

Figure 5(b). Wave shape of FCCR for Fixed Input.

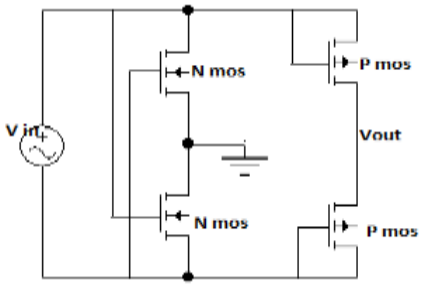

Figure 6(a). Gate cross Coupled Rectifier (GCCR)

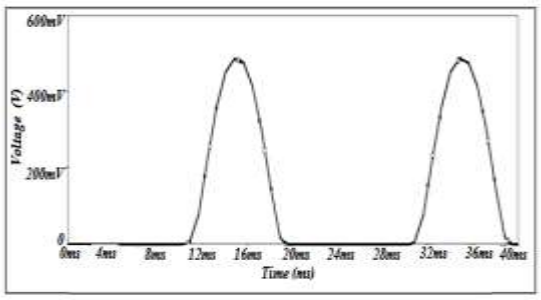

Figure 6(b). Wave shape of GCCR for Fixed Input

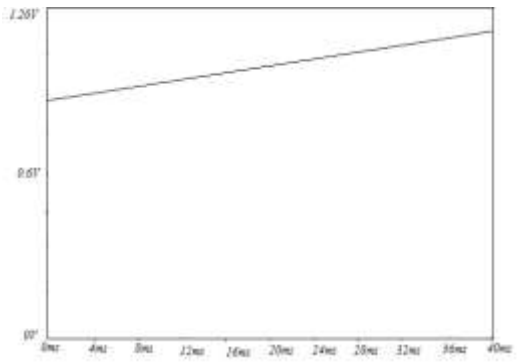

Figure 7. Figure of Overall Voltage for Leakage Paths After Adding Nine Paths of Leakage Current

In between these two rectifiers, we got almost same waveform. In contrast, the achieving values were different. In the case of using FCCR, we got the high achieving values compared to use GCCR. In our case, we used the FCCR due to get highly rectification curve, which is as clear as understanding. Moreover, in the case of threshold voltage, it is possible to solve the threshold voltage drop problem by using the FCCR whereas it's impossible to use GCCR [18].

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

5. CONCLUSION

Solar panels basically used for different purposes where electrification is the most important one. PV-TRX- less inverter topology is bringing the vital role to produce electricity with less cost with high efficiency. Hence, LC is occurred with different places. In above shows these places with simulated results. Furthermore, here is used a summer circuit for adding all of these currents. Additionally, convert the signal used a rectifier and used amplifier to amplified the achieve DC singal which is ~1V.

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