IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 11, Issue 4, April 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.18

A Novel Flexible DC- DC Flyback Converter for Hybrid Viable Energy System

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ABSTRACT: Unique of the most thoroughly researched research fields among renewable energy sources is photovoltaic (PV) power conversion. Inverters, which are critical in the power conversion process, have also been upgraded for interfacing ac applications and PV system ac grid integration. Micro inverters are one of the most modern inverter topologies used to connect solar PV facilities to the utility grid and ac loads. The flyback micro - inverter with pseudo -dc -link is popular for photovoltaic applications because it is a simple topology, but it has a high transformer turns ratio and hence a high leakage inductance, which reduces converter efficiency. To address this issue, this work developed an isolated interleaved flyback micro-inverter with high voltage gain andlow voltage stress that is easily available in a reduced transformer turns ratio, based on a non-isolated pseudo-dc-link construction. With more efficiency, the operation of the flyback micro -inverter and accompanying controllers is analysed analytically using SIMULINK.

KEYWORDS: DC-DC Flyback Converter, Hybrid Renewable Energy System, Reactive Power, Battery Storage.

I. INTRODUCTION

Due to environmental pollution and fossil fuel exhaustion, renewable energy sources have gotten a lot of attention. As a sort of renewable energy, photovoltaic generation systems are being actively explored. For grid connectivity, there are a variety of PV system designs available, including centralised, string, multi-string, and AC-module systems. A low-power grid interactive inverter is placed on each individual PV module in the ACmodule type. The AC-module type has the benefit of not requiring a costly DC power distribution connection. These PV schemes are also resistant to mismatch issues caused by partial shade between PV modules.

However, the lower efficiency of AC-module systems must be overcome in comparison to other types. Because of their galvanically isolated structure, ease of expanding voltage gain, and fewer devices required than other topologies, flyback inverters are often utilised for AC-module applications. A traditional flyback inverter uses a flyback converter and an unfolding bridge to convert the DC current and voltage of a PV module to AC power. Another way for increasing efficiency is interleaving operations. Because the current is divided between two parallel converters, the active and passive devices' current ratings are reduced, and the divided current might lower the system's conduction loss.

It can also lower the size of the high-frequency transformer and the input capacitor's current ripple. Micro-inverters are well-documented in the literature, and the flyback-based architecture is the most appealing due to its simple current control, low part count, and possibly low cost. There are three operating modes for flyback type micro-inverters: discontinuous (DCM), continuous (CCM), and boundary conduction modes (BCM). The DCM operation is frequently favoured because the injected present into the grid can be controlled via open loop control without the use of a current sensor. Many candidate soft switched converters have been proposed in the literature to magnify the PV voltage in the first stage .

Furthermore, when a high voltage gain is required, isolated DC/DC PWM converters may be preferred. Resonant converters, on the other hand, may not perform well under a wide load range, such as PV power, which swings from zero to rated power throughout the day. The isolated interleaved flyback microinverter is intended and equated to a traditional counterpart in this work. The three -phase inverter is then employed for utility grid processing.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 4, April 2022||

|DOI:10.15662/IJAREEIE.2022.1104028 |

II. PROPOSED TOPOLOGY

There are three pieces to the PV-AC module system. The PV module is the initial component, which provides output voltage dependent on irradiation. The interleaved flyback converter, which produces a 410V output voltage, is the second portion. In terms of power density and conversion efficiency, BCM operation of the flyback converter has various advantages over DCM operation. The lower switching loss allows for higher switching frequency and a more compact design because the BCM operation provides a natural ZVS turn-on for the primary switch. Finally, there's the three-phase inverter circuit, which provides a high-efficiency connection to the utility grid.

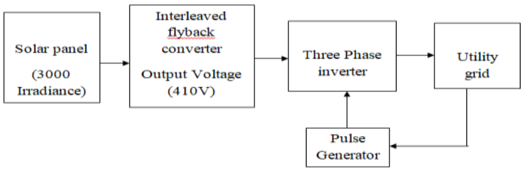

FIG 1.Proposed Topology Diagram

III. STRUCTURE AND OPERATING PRINCIPLES

A simulation design of a single flyback configuration has been provided as a preliminary design of the recommended converter topology. The proposed system is enhanced in flyback topology, where each interleaved phase line is connected to independent HF transformers, whereas the preliminary study was based on a two-phase interleaved converter with galvanic isolation. As a result, when compared to a standard two-phase interleaved converter, the overall gain of the dc bus voltage and the converter's power rate are enhanced. On the other hand , an RCD snubber has been incorporated into the design , as well as magnetising inductance, to ensure that the converter operates in continuous conduction mode (CCM).

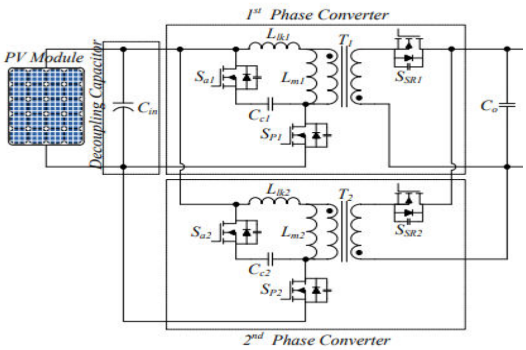

FIG 2.INTERLEAVED FLYBACK

IV. CONVERTER OF PROPOSED SYSTEM

This section contains a detailed mode analysis of the high and low output power ranges. There is a 180-degree phase delay gap between the first and second converters, but they are otherwise similar. For the sake of simplicity, operation analysis is only described for one converter. During TS, the voltages Vin and Vo, as well as the reference current iref, are also expected to be constant. Furthermore, because the converter functions under BCM, the auxiliary switch Sa is always on. Following that is a description of each operation mode.

1) Mode 1: The switch S is turned on just before t0, and the magnetising inductor current iLm climbs linearly from zero to iref. At this point , the switch S is turned off , and Mode 1 is activated.

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Analysis of steady-state behaviour of modified SEPIC high gain converter: All the elements are taken as ideal for simplifying the analysis. The capacitor voltages are determined by using a volt second law on the passive devices (L1, L2, L3 and LO)

$$VC1 = 2DVg /1 - D \quad (1)$$

$$VC2 = D\, Vg /1 - D \quad (2)$$

$$VC3 = Vg /1 - D \quad (3)$$

$$VCb1 = VCb2 = [1 + D]Vg /[1 - D]^2 \quad (4)$$

The voltage, VO of the MSHG converter is,

$$VO = 2VCb1D + VCb1(1 - D) \quad (5)$$

$$GV = VO /Vg = (1 + D /1 - D)^2 \quad (6)$$

Equation (6) presents the voltage conversion ratio of the MSHG topology with N = 1, where N = number of voltage expander cells,

$$GV-EVEN = VO /Vg = [1 + D][(N + 1) - D] /[1 - D]^2 \quad (7)$$

$$GV-ODD = VO/ Vg = [1 + D][(N + D] /[1 - D]^2 \quad (8)$$

Equations (7) and (8) give the voltage conversion ratio of derived topology for even and odd numbers of gain expander cell, respectively1756.

Graph content:

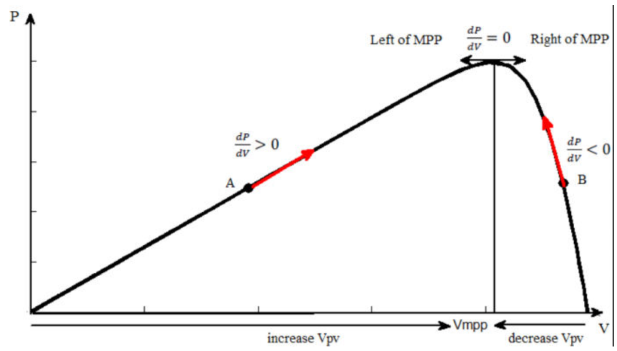
1.The figure shows that the solar input Voltage and Current based on the irradiance on it. It will be used for further processing of the system.

2. The isolated SEPIC converter output voltage shown in the figure shows that the gained voltage levels of the input signal.

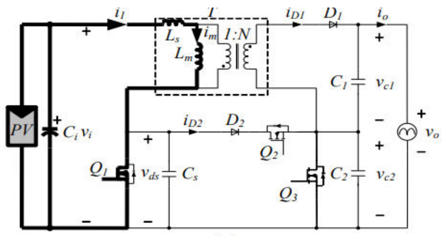
3. The final stage of the system which is the single phase inverter output which provides the alternated current output for the grid load.

Proposed: (Additional)

Solar panels have a nonlinear voltage-current characteristic, with a distinct maximum power point (MPP), which depends on the environmental factors, such as temperature and irradiation. In order to continuously harvest maximum power from the solar panels, they have to operate at their MPP despite the inevitable changes in the environment. This is why the controllers of all solar power electronic converters employ some method for maximum power point tracking (MPPT).The maximum power point tracking system used in the proposed system used to acquiring maximum power from the solar panel and used to provide triggering pulses for the converter switches.



The figure shows that the basic concept behind MPPT for efficient power tracking.



(a)

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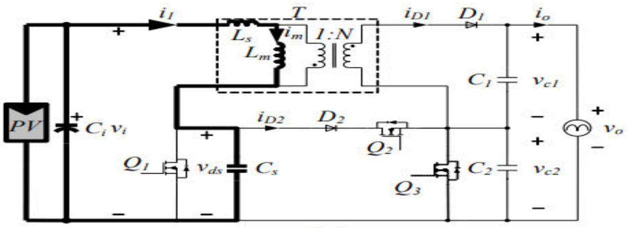
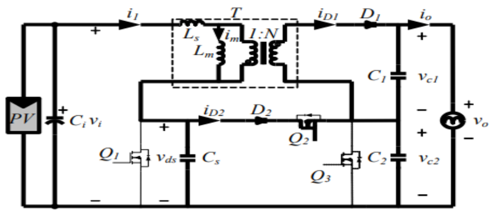
2) Mode 2: At t1, switch S is turned off, and the resonance between inductors (Lm, Llk) and capacitors (Cs, Coss) commences, with Coss serving as the switch S's parasitic capacitor. Due to the huge magnitude of the magnetising inductor current at turn-off, the duration of this mode is relatively short compared to the entire resonant period, and the voltage vds climbs virtually linearly.



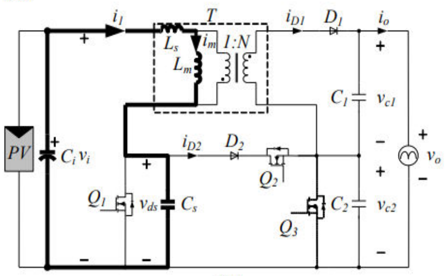
(b)

3) Mode 3: The magnetising inductor Lm's stored energy is delivered to the output side. The output diode current iD reduces linearly to zero, minimising the reverse-recovery effect of D. The voltage vds maintains the constant value of Vin+Vo/N during this mode if the leakage inductance is assumed to be zero as an ideal state to simplify the operational analysis . The leakage inductance, on the other hand , creates a high frequency oscillation at the start of this mode in the actual world.



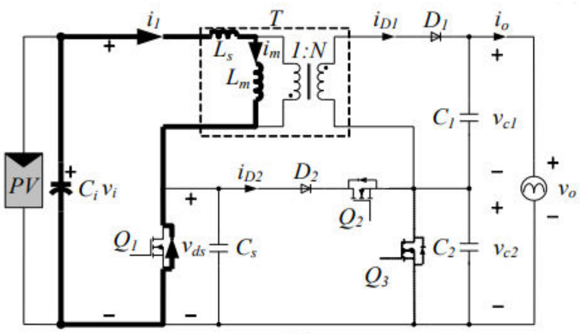
(c)

4) Mode 4: Like Mode 2, this is a resonant mode. Regardless of the quantity of energy stored in the magnetising inductance, the voltage vds declines to zero in a resonant manner within the maximum of half resonant time as indicated in (7).



(d)

5) Mode 5: The ZVS turn-on is satisfied by applying the gating signal of the switch S while the current iLm flows negatively via the anti-parallel diode of the switch S. Half of the resonant period is used to calculate the time delay Td between zero magnetising current and switch S turning on.



(e)

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IV. SIMULATION RESULTS

Simulink is a graphical programming environment for modelling , simulating , and analysingmultidomain dynamical systems developed by MathWorks. Its main interface consists of a graphical block diagramming tool and a set of block libraries that can be customised. It has a close interaction with the rest of the MATLAB environment and may be used to either drive or script MATLAB. Simulink is a multidomain simulation and Model-Based Design tool that is frequently used in automatic control and digital signal processing . To examine and initially validate the theoretical analysis, simulations are run using MTALAB/Simulink software.

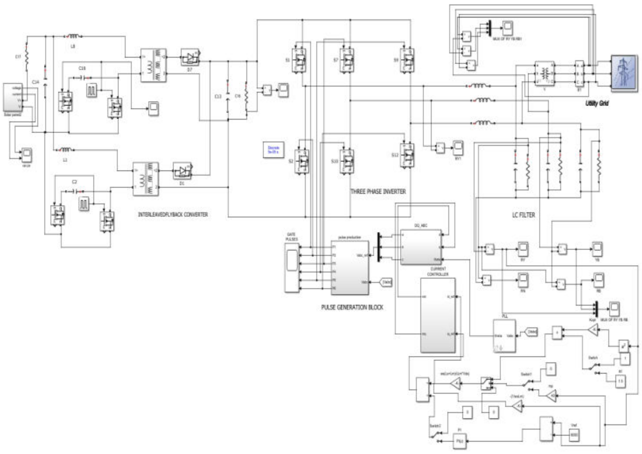

FIG 3. Simulation Diagram

STIMULATION OUTPUT

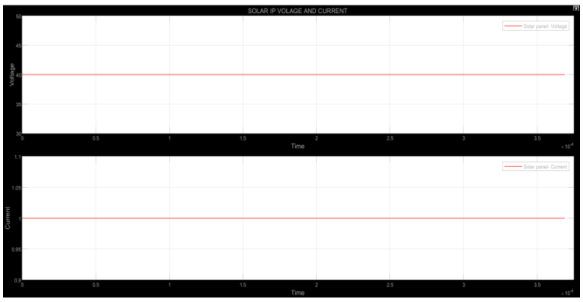

FIG 4. Input Voltage I

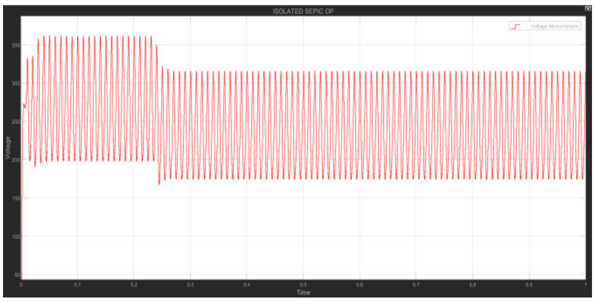

FIG 5. Input Voltage II

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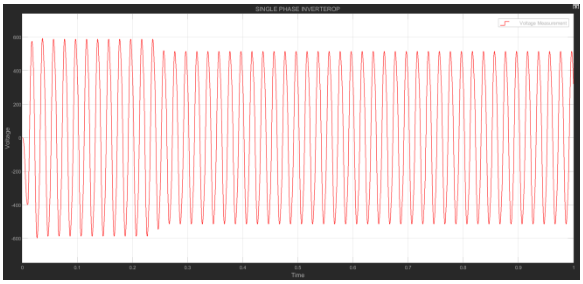

FIG 6. Output Voltage

V. CONCLUSION

This work proposes a tiny inverter topology and control approach for renewable energy applications. Because of their simple structure and low power applications, micro inverters are gaining popularity. The power range and operation in a single PV module connection, on the other hand , provide distinct control issues. An isolated interleaved flyback converter based microinverter has been proposed in this study, with a two-stage interleaved flyback converter as the first stage and a three-phase inverter architecture as the second stage. Simulated and experimental results have resulted in a system with a lower turns ratio , reduced leakage inductance, lower voltage stress, and intrinsic snubber, resulting in a higher overall converter efficiency.

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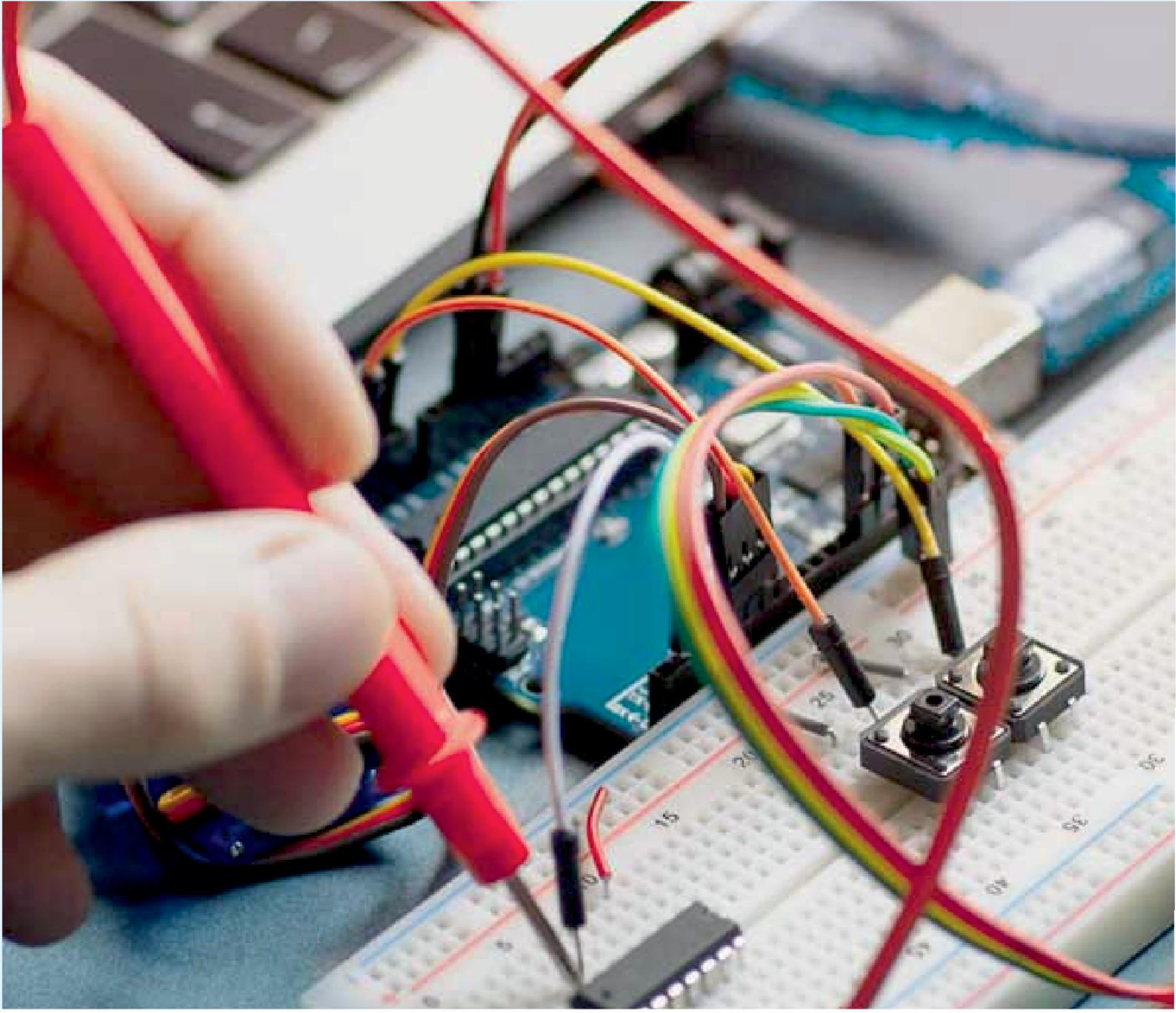

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