International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 06 | June - 2021 ISSN: 2582-3930

HYBRID INVERTER WITH SOLAR BATTERY CHARGING

Karthik kumar G R[1], Leela sai Krishna G[2], Charan kumar G[3], Harsha M S[4], A M Nagaraj[5]

[1]*Electrical & Electronics Engineering, DSCE* [2]*Electrical & Electronics Engineering, DSCE*
[3]*Electrical & Electronics Engineering, DSCE* [4]*Electrical & Electronics Engineering, DSCE*
[5]*Electrical & Electronics Engineering, DSCE*

---***---

Abstract - Solar energy has tremendous potential for illuminating our everyday life. According to researchers, the quantity of sunshine that hits the Earth's surface in an hour and a half is enough to power the whole globe for a year. Solar energy is one of the most cost-effective and environmentally benign renewable energy technologies available. I suggested methods for my study that may be used to other off-grid applications. I'll use an off-grid bus shelter as an example to demonstrate design process. Independent systems that are not linked to any electrical grid are known as off-grid or standalone systems. These are available in a variety of sizes and are often utilised in areas with limited access to grid infrastructure. The off-grid bus shelter project will run entirely on solar energy, with solar photovoltaic panels harvesting electricity to power gadgets including LED lights, a Wi-Fi router, and a billboard. In the event of unexpected weather circumstances, a battery backup would provide an uninterrupted power supply. This article will look at how off-grid/stand-alone system approach may assist to decrease grid dependence and enable us to live self-sufficiently without relying on one or more public utilities. To illustrate the idea, a PV system will be built for a bus shelter at EIU.

***Key Words*:**Solar energy, hybrid inverter, back-up power supply.

1.INTRODUCTION

Energy, like food and water, is a need. All around us needs energy. Over the years, the earth's population has increased, which is also directly proportionate to the energy consumed. All conceivable equipment and devices need some or other kind of energy to work. With the depletion of fossil fuels, effective renewable energy supplies must be identified that may reduce dependence on fossil fuels. This section presents recommendations and methods to the size and design of the stand-alone off-grid photovoltaic system. In principle, a variety of off-grid system configurations are conceivable from a smoother design to a somewhat complicated one, based on its power and load characteristics as well as on-site energy supplies. The main objective of the off-gird system design should, however, be to achieve optimum efficiency, dependability, and flexibility at an affordable price. The next parts address the design of solar photovoltaic systems for off-grid electrification projects while taking the aforementioned considerations into account.

2. DESIGN OF THE MODEL

Off-grid solar system:

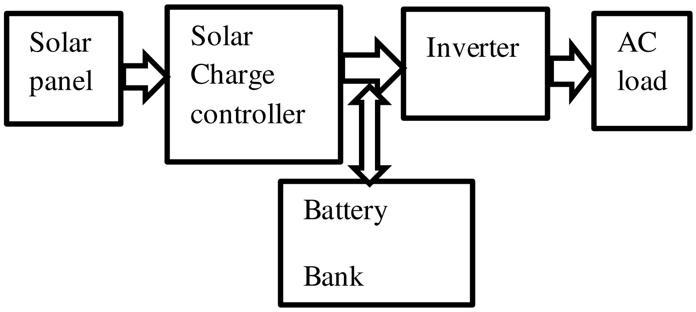

Fig 1 Solar off-grid inverter schematic diagram

Figure 1 depicts the schematic diagram of the proposed multi-input inverter. An integrated buck/buck-boost fused multi input direct current–direct current converter and a full-bridge direct current–alternating current inverter are used in this design. When using the PV array and the rectified wind turbine output voltage as input dc voltage sources, we get the following results: and The multi-input dc–dc converter can draw the maximum amount of power from both the PV array and the wind turbine individually or simultaneously by employing the pulse-with-modulation (PWM) control scheme in conjunction with an appropriate MPPT algorithm on the power switches and the power converter. This will be accomplished through the use of sinusoidal pulse width modulation (SPWM) control on the dc bus voltage, in order to achieve input-output power-flow balance. Detailed descriptions of the operation principle of the proposed multi-input inverter are provided as follows:

A PV Array A PV array is made up of many solar panels that are connected in series or parallel.

Photovoltaic (PV) cells. Each solar cell is made up of a – junction semiconductor, which can generate currents as a result of the photovoltaic effect on its surface.

3. INVERTER

While an inverter is a device that transforms a direct current (DC) voltage into alternating current (AC), it is composed of four switches, while a half-bridge inverter is composed of two diodes and two switches linked in anti-parallel. It is important to note that the two switches are complimentary in that when the first switch is turned on, the second switch will be turned off. In the same way, when the second switch is turned on, the first switch will be turned off.

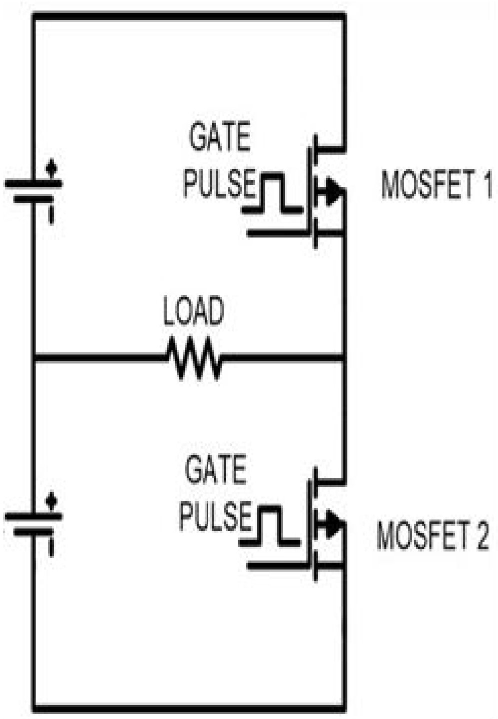

Fig 2 Circuit diagram: Half-bridge inverter

When switch S1 is turned on for a time period of 0 to T/2, switch S2 is turned off. This is how it works in Case 1 (when switch S1 is turned on and switch S2 is turned off).

Using KVL (Kirchhoff's Voltage Law) as a guideline

Vs/2-V0=0

In the case when the output voltage V0=Vs/2

i0 is the output current when the input voltage V0/ equals the output voltage Vs/2R.

In the case of supply current or switch current, the current iS1 = i0 = Vs/2R, the current iS2 = 0 and the diode current iD1 = iD2 = 0 are all equal.

If case 2 is true (when switch S2 is on and switch S1 is off), then when switch S2 is on for a length of time equal to T/2 to T, the switch S1 is turned off. Using KVL (Kirchhoff's Voltage Law) as a guideline

Vs/2+V0=0

In this case the output voltage V0=-Vs/2

In which the output current i0 = V0/R= -Vs/2R and the input current i0 = V0/R=

In the case of supply current or switch current, the currents iS1 = 0, iS2 = i0 = -Vs/2R, and the currents of the diodes iD1 = iD2 = 0 are obtained.

FIGURE 3 depicts the waveform of the single-phase half-bridge inverter output voltage as it is produced by the inverter. When we use an inverter, we do not receive a pure sinewave, but rather a square wave as the output voltage. Figure 4 depicts the output voltage with the fundamental component included.

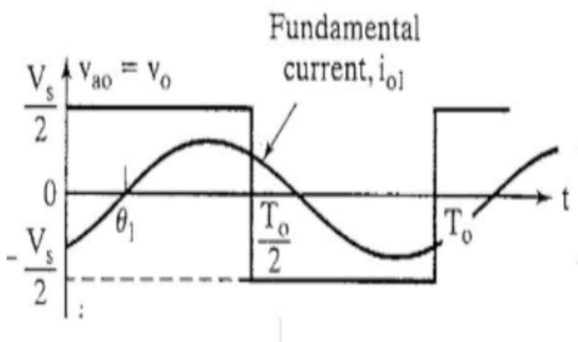

Fig 3 Decomposition of a square wave into sinusoidal waves using the Fourier series

$$V_{0(\omega t)} = V_{0(avg)} + \sum_{n=1}^{\infty} C_n sin(n\omega t + \phi_n)$$

Where C_n, a_n and b_n are

$$C_n = \sqrt{a_n^2} + \sqrt{b_n^2}$$

$$a_n = \frac{2}{T}\int_0^T V_0(\omega t)cosn\omega t.d\omega t = 0$$

bn=VS/nπ(1-cosnπ)

When replacing even numbers (n=2, 4, 6, etc.), the bn =0, and when substituting odd numbers (n=1, 3, 5, etc.), the bn =2Vs/n. When bn =2Vs/n and an=0 are substituted in Cn, the result is Cn=2Vs/n.

ϕn=tan-1(an/bn)=0

V_{01}(t)=2 V_m/* (Sin t)

Substitute $V_{0\,(avg)} = 0$ in will get

$$V_{0(\omega t)} = 0 + \sum_{n=1,3,5} \frac{2V_s}{n\Pi} sin.n\omega t$$

$$V_{0(\omega t)} = \sum_{n=1,3,5} \frac{2V_s}{n\Pi} sin.n\omega t.........eq(1)$$

Alternatively, the above equation can be written as
$V_{0(\omega t)}=2V_S/\pi$ * (Sin ωt) + $2V_S/3\pi$ * (Sin3ωt) + $2V_S/5\pi$ * (Sin5ωt) +……..+∞
$V_{0(\omega t)}= V_{01(\omega t)}+ V_{03(\omega t)}+ V_{05(\omega t)}$

The voltage represented by the above equation is the output voltage, which is made up of the fundamental voltage and odd harmonics. It is possible to eliminate these harmonic components in two ways: either via the use of a filter circuit or through the use of pulse width modulation technology.

The fundamental voltage may be expressed as V01(t)=2VS/* (Sin t) where V01(t) = 2VS/* (Sin t) is the time constant.

The maximum value of fundamental voltage V01(max) =2VS/ is the maximum value of fundamental voltage.

The root-mean-square (RMS) value of the fundamental voltage is

$V_{01(RMS)} =2V_S/\sqrt{2}\pi=\sqrt{2}V_S/\pi$

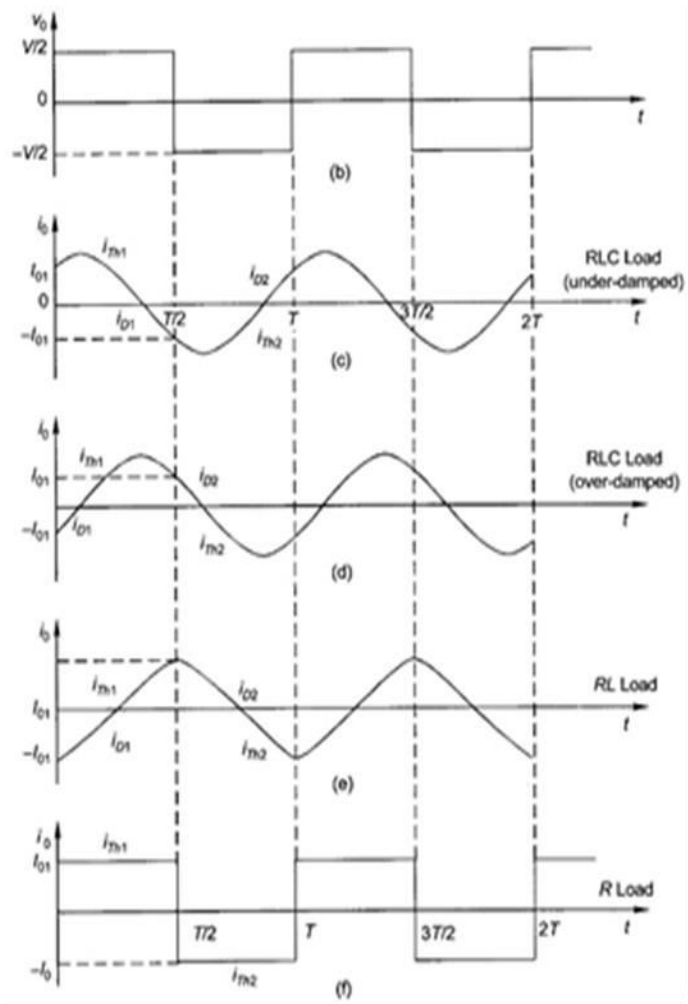

Fig 4 Output voltage waveforms: Half-bridge inverter

4.BATTERY CHARGING SYSTEM

With the increasing demand for electricity, an alternate option would be to utilize solar energy as a source of electricity production, which would help to alleviate the deficit of electricity now in place. Aside from that, rural regions afflicted by poverty are the ones that suffer the most from the power shortage. In order to make solar energy conversion devices more widely used as a renewable energy source, the goal is to increase public awareness of their benefits. Solar energy has the potential to capture enormous quantities of energy. Compound solar cells are used in the construction of solar panels. Solar batteries charge in a relatively short period of time. Solar energy is transformed into electrical energy, which is then stored in these batteries for later use. Because of this, the utilization of solar energy as a renewable energy source will have a significant effect on the global energy crisis's solution in the near future.

An SCC, regulates the amount of electric current that is taken from or added to the battery. It protects the battery from being overcharged, which is one of the reasons that contribute to the battery's reduced life. Additionally, it protects the battery from being completely discharged by using regulated discharge. SCCs prevent the battery from charging when the battery voltage reaches a high voltage level threshold and let the battery to charge again when the voltage falls below that threshold. Pulse width modulation (PWM) and Maximum Power Point Tracker (MPPT) are two common methods for charging batteries. PWM adjusts the charging rates based on the voltage level of the battery, while MPPT charges the batteries closer to their maximum capacity by adjusting the charging rates based on the voltage level of the battery.

A consistent output voltage is produced by controlling the duty ratio of the switches using pulse width modulation (PWM). The direct current voltage is transformed to a square-wave signal that alternates between being totally on and being completely off. PWM is a method of digitally recording the levels of analogue signals. It also has the ability to regulate the amount of current that is used to charge the battery and to offer trickle charging. With the voltage mode PWM controller, we have all of the capabilities required for basic voltage mode operation at our disposal. This PWM controller has been designed to operate at high frequencies on the main side of the control signal. In addition to its distinctive features and advantages, this kind of controller includes the following characteristics:

• A sink/source gate drive for high efficiency operation.

• Up to 1MHz fsw, which aids in the optimization of size or efficiency.

• External voltage reference, which reduces the number of components require.

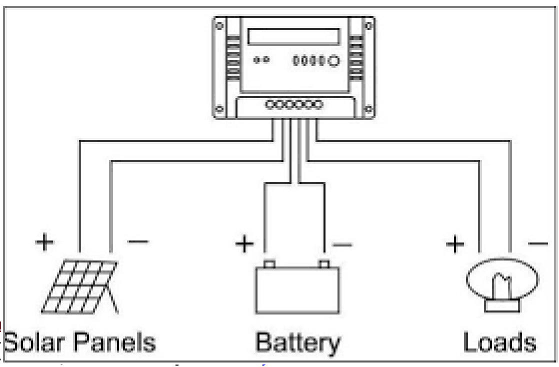

Fig 5 PWM based solar charge controller

6.CONCLUSION

In the SIMULINK software tool, a half bridge inverter model with solar PV module input is simulated, and the results are shown in figures 6, 7, and 8.

The output voltage of the PV module is a direct current (DC) voltage (figure 6), which is transformed into a rectangular waveform by the converter (fig.7). This rectangular periodic wave is a combination of various sinusoidal components (harmonics), of which the fundamental component with the greatest magnitude is obtained as an output by passing the rectangular waveform through a band-pass LC filter with the required cut-off frequency as shown in the illustration. As a result, the ultimate intended output, which is a pure sine wave, is achieved (fig.8.).

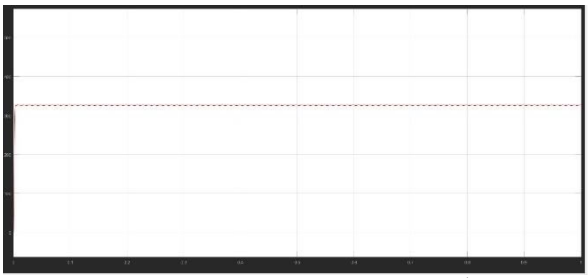

Fig 6 PV array output (DC voltage)

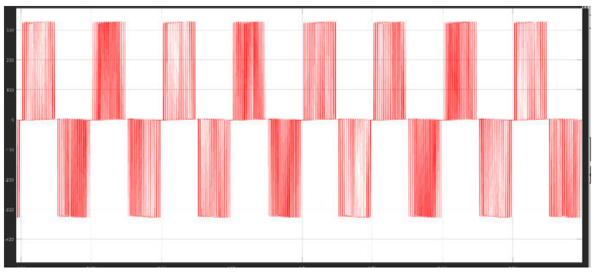

Fig 7 Rectangular voltage wave (Inverter output)

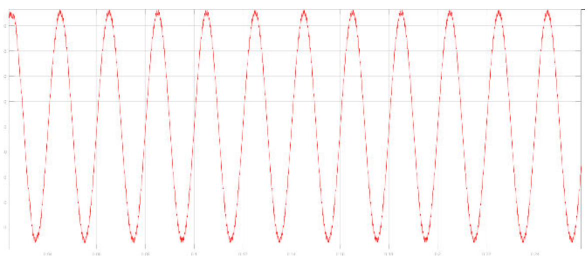

Fig 8 Pure sinusoidal voltage output (filter output)

While coming to the working of hardware model (Fig 9) ,it consists of a Lithium battery which is being charged by two sources:Solar charging system,AC mains charging system.While the AC mains power is available,the load is run by AC mains,while the battery is being charged.

When the climatic conditions are suitable,Solar PV array charges the battery through pwm solar charge controller. When AC mains power is disconnected, battery starts powering the load.

Fig 9 Hardware model: Hybrid inverter and battery charging system

REFERENCES

[1] P. G. Ochnev and Y. B. Shchemeleva, "Renewable Energy: Hybrid Inverter," *2020 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM)*, 2020, pp. 1-6, doi: 10.1109/ICIEAM48468.2020.9111952.

[2] G. Carli and S. S. Williamson, "Technical Considerations on Power Conversion for Electric and Plug-in Hybrid Electric Vehicle Battery Charging in Photovoltaic Installations," in *IEEE Transactions on Power Electronics*, vol. 28, no. 12, pp. 5784-5792, Dec. 2013, doi: 10.1109/TPEL.2013.2260562.

[3] ALTE store. (n.d.). THE ROLE OF AN INVERTER IN A SOLAR ELECTRIC SYSTEM. Retrieved from ALTE store: https://www.altestore.com/howto/the-role-of-an-inverter-in-a-solar-electric-system-a15/

[4] Alternative Energy.(n.d.). Solar Inverter Sizing. Retrieved from altenergy: http://www.altenergy.org/renewables/solar/DIY/inverter-sizing.html

[5] Bosshard, P. (2006). An Assessment of Solar Energy Conversion Technologies and Research Opportunities. Stanford University. Retrieved from Stanford.edu.

[6] Desideri, U., Zapparelli, F., & Garroni, E. (2013). Comparative analysis of concentrating solar power and photovoltaic technologies: Technical and environmental evaluations. Science Direct, 765-784.

[7] Energy.gov. (n.d.). Grid-Connected Renewable Energy Systems. Retrieved from Energy.gov: https://www.energy.gov/energysaver/grid-connected-renewable-energy-systems.

[8] Franklin, E. (2017, August). Solar Photovoltaic (PV) Site Assessment. Retrieved from Cooperative extension: https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az 1697-2017.pdf

[9] Northern Arizon Wind and Sun. (n.d.). All about Maximum Power Point Tracking (MPPT) Solar Charge Controllers. Retrieved from Northern Arizon Wind and Sun:https://www.solar-electric.com/learning-center/batteries-and-charging/mppt-solar-charge-controllers.html

[10] NREL. (n.d.). NREL's PV Watt calculator. Retrieved from NREL: https://pvwatts.nrel.gov/

[11] Pelamis wave power. (n.d.). Solar Panel Size Guide: How Much Do You Need For Your Home? Retrieved from .pelamiswave.com: https://www.pelamiswave.com/solar-panel-size-guide/

[12] N. Sasidharan and J. G. Singh, "A Novel Single-Stage Single-Phase Reconfigurable Inverter Topology for a Solar Powered Hybrid AC/DC Home," in *IEEE Transactions on Industrial Electronics*, vol. 64, no. 4, pp. 2820-2828, April 2017, doi: 10.1109/TIE.2016.2643602.

[13] G. M. Sharif, S. M. M. Islam and K. M. Salim, "Design & construction of microcontroller based maximum power point PWM charge controller for photovoltaic application," *2009 1st International Conference on the Developements in Renewable Energy Technology (ICDRET)*, 2009, pp. 1-4, doi: 10.1109/ICDRET.2009.5454228.