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SMART INVERTER

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Abstract—This project development of a smart inverter that can monitor the energy usage of different appliances. A smart inverter is a inverter that measures the electricity generation, consumption and provides other additional features such as high accuracy which makes it more advantageous than the traditional inverter. The proposed inverter model is verified by designing an appropriate circuit and associated hardware. The hardware is designed using a microcontroller atmega328, current and voltage transformer, voltage regulator 7805, solar panel, solar charge controller and inverter. The developed inverter can control the energy supply and usage of the consumers accurately based on load requirement. In addition, the inverter can calculate the cost of power consumption of convection grid and solar energy. Thus, the consumer will get a clear idea about the costs of their usage. Hence, the proposed system is more advantageous than the traditional system which will reduce the manpower, cost and time

Keywords—Arduino UNO, INVERTER, Battery, Solar panel

I. INTRODUCTION

In recent years the power sector has been undergoing substantial changes which are causing a global rethinking of the system and its infrastructure. Among the reasons for this are an evolution in the criteria of consumer demand regarding, for example, energy consumption habits and the power quality levels required. At a global level, the strategic need of countries to diversify energy sources, linked to the increasing development of renewable energy sources, have led to an increase in the coexistence of conventional generation systems and Distributed Energy Resources (DERs). This rapid development of renewable energy generation within electrical systems is mainly due to the development of viable technological solutions and state policies aimed at boosting countries' own energy resources and at reducing dependence on energy imports.

The economic costs of renewable energy installations are becoming more competitive, leading to a growing penetration of supply. In the particular case of photovoltaic (PV) systems, the low cost

of panels means that PV installations are proliferating, especially among domestic users. A question that has become relevant in recent times is that, since by its very nature photovoltaic generation is intermittent, a high penetration of PV resources can lead to grid instability if PV generation is not regulated properly. According to some authors, these effects begin to be significant in distribution areas where PV energy penetration reaches between 10 and 15 percent. This means that those areas where solar energy is an important part of the grid find themselves exposed to greater economic costs due to outages and increased maintenance needs.
The approach to solving this increasing problem is to make inverters smarter.

II. LITERATURE SURVEY

Individuals and researchers across India have over the years taken advantage of the provision of abundant solar resources and its simple use to style photovoltaic (PV) systems to satisfy their private energy needs. Udoakah et al. [5] designed a 1 kVA PV system for the electrical laboratory within the Faculty of Engineering at the University of Uyo to unravel the matter of sudden power failures during laboratory sessions. the key components of their off-grid PV system design include two 150 W solar panels connected in parallel (PV module), an inverter unit, one 12 V, 100 AH deep cycle battery, a charge controller unit, and an automatic control unit to automatically switch from the inverter to the general public power supply whenever the general public power was available and the other way around. Elsewhere, Okoye et al. [3] proposed a stand-alone solar PV system design solution and value model analysis using both intuitive and numerical methods. The authors considered constant electrical load demands of a house each in three different major cities in India: Onitsha, located within the southeast region; Kano, located in the northwest region; and Lagos, located within the southwest region as case studies using the 2016 meteorological radiation data sets for these cities in their analysis. In their solution, they used intuitive and numerical methods to calculate the specified PV area and capacity, the quantity of PV modules, the corresponding capacities of the battery, the inverter, and therefore the charge controller while using the life cycle analysis model to research the optimal cost solution for the PV system design which takes under consideration the initial capital investment, the current cost of the battery, the inverter, the charge controller, and therefore the balance of system cost to estimate the web present value of the PV system similarly because the estimated future value of the system using appropriate discount rates for every one of the components of the PV system. Akinyele and Rayudu [6] proposed an off-grid PV system design solution to unravel electric power problems in two rural households in India using HOMER software for the modeling and analysis of the PV system and price. In their research, they considered energy consumption scenarios of two households in the Agwandodo settlement in Gwagwalada, Abuja, with moderate loads. Considering the common loads and operating hours of the domestic appliances for every one of those houses, they used both MATLAB and HOMER tools to get the daily load profiles for the 2 houses. They then used HOMER software to get the optimized component sizes of the stand-alone PV systems for the homes and costs.

In yet one more development, Adaramola et al. [7] presented the feasibility analysis of hybrid PV solar-diesel installation applications for remote areas within the northern part of India using Jos and its environs in Plateau State as a case study. In their solution, the electricity of 1.5 MWh per day with a daily peak load of 236 kW was simulated for rural areas with a population of about 1,500 households and with the belief that every household consumed 1 kWh of energy per day. The values were then wont to determine the ratings of the opposite components of the proposed hybrid PV solar-diesel system including PV modules, diesel generator, battery, and power converter.

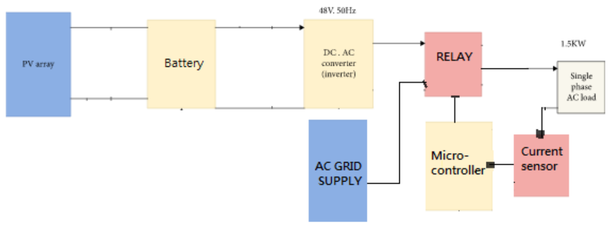
In most of the above-mentioned papers, the energy requirements for his or her hybrid/PV system design are estimated by calculating the facility requirement of every device within the house and estimating the approximate number of hours each device would utilize power in a very day. the matter with this method of estimating energy needs for PV system design is that it doesn't consider the sort and size of the locations of electrical appliances, the building materials, orientation and dimensions of the house, and warmth loss through the walls, windows, doors, and roofs of the house. Also, the intuitive and numerical methods of estimating energy requirements presented within the other papers above have some drawbacks. Although the intuitive methodology is comparatively simple to compute compared to the numerical method, it's the disadvantage of often oversizing or under-sizing the complete system thanks to not modeling the interactions among the subsystem components [3]. The numerical method, on the opposite hand, could be a complex solution vulnerable to errors because it involves lots of parameter estimations.

In this paper, the enumerated shortcomings above are addressed in designing a hybrid power grid. This paper involves three major tasks. Firstly, in-depth thermal modeling of the chosen house using BEopt software is completed. Secondly, an optimum hybrid facility design using HOMER Pro software is presented. Finally, MATLAB/Simulink dynamic simulation of the optimum PV system component of the proposed hybrid facility is presented together with the simulation results. Specifically, the contributions of this study include the following: (i)Thermal modeling of the house, taking under consideration important parameters like the sort and size of the house, location and orientation of the house, materials utilized in building the house, number and kinds of appliances within the house, and a number of occupants, furthermore as heat loss through the walls and windows. Such modeling resulted in an exceedingly detailed hourly and annual load profile of the house. This, to the most effective of the authors' knowledge from reviewed literature, has never been finished the determination of load profiles in this region(ii)Determination of the optimal renewable energy mix and traditional diesel generator size of the hybrid grid for the particular house in India(iii)Assessment of the optimal system configuration to realize energy independence for the house(iv) simulation of the PV system component of the proposed hybrid installation to check the facility quality, harmonics, load impact, and voltage transients under various conditions specific to the house into consideration.

III. BLOCK DIAGRAM AND DESCRIPTION

The inverter is meant to deliver a maximum power of three KVA including losses by converting the 24 VDC input from the battery bank to 230 VAC. The microcontroller is programmed to hold out different controls and to also produce a multilevel pulse width modulation (MPWM). The controls include the fully-charged control, overload control, and low battery control. The fully charged control switches OFF the charging process when the battery voltage charges up to twenty-eight VDC. The overload control switches OFF the inverter outputs when a load connected is on top of 2.8 KVA. The low battery control switches OFF the inverter when the battery voltage drops below 20 VDC when on inverter mode. The system is intended to charge with a relentless current of 10 Amp regardless of fluctuations within the mains input voltage. The system was tested by connecting a 400 watts bulb to the output. The output went OFF when the battery voltage dropped below 20 VDC. The output waveform when tested with an oscilloscope produced a pure wave.

The developed microcontroller-based pure wave inverter with controlled output consists of an ATMEGA328 microcontroller programmed to carry out all the control functions and also the production of a multilevel pulse width modulation, a MOSFET driver (IR2112) which increases this and voltage level of the heartbeat width so it can drive the MOSFET, a H-Bridge MOSFET Network for the assembly of the sine waveform, a Filter to get rid of the high harmonics components from the undulation generated, a transformer with three taps on the high voltage winding and relay network for changeover purpose.



IV. HARDWARE REQUIREMENTS

For building a prototype module we'd like the following components:

- Solar Panel

Photovoltaic (PV) panels are manufactured using A-grade solar cells to make sure high efficiency in every application. Sola-Max panels are aesthetic in appearance and have a high-performance level even in low light conditions because of the superior cells

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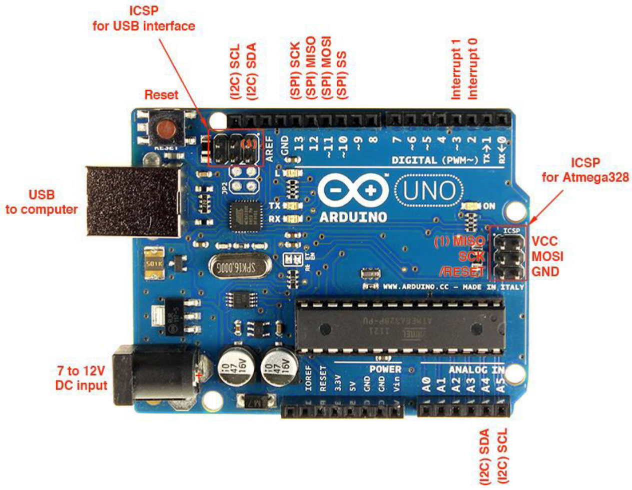
used. High transparent glass is employed in our panels to make sure maximum output and protection against the weather.

The anodized aluminium frame will assist in withstanding wind pressure while ensuring simple installation.

- Arduino

Arduino is an open-source, hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects which will sense and control objects within the physical world. during this project, we used it to sense and control the relay circuit.



- Battery

An electric battery could be a device consisting of 1 or more electrochemical cells with external connections provided to power electrical devices like flashlights, smartphones, and electric cars. When an electric battery is supplying power, its positive terminal is that the cathode and its negative terminal is that the anode. The terminal marked negative is that the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When the battery is connected to an external circuit, electrolytes are ready to move as ions within, allowing the chemical reactions to be completed at the separate terminals then deliver energy to the external circuit. it's the movement of these ions within the battery which allows current to effuse of the battery to perform work.

A battery's capacity is the amount of electrical charge it can deliver at the rated voltage. The more electrode material contained within the cell the greater it's capacity. a little cell has less capacity than a bigger cell with identical chemistry, although they develop the identical open-circuit voltage. Capacity is measured in units like amp-hour (A-h). The rated capacity of electric battery is typically expressed because the product of 20 hours multiplied by this that a replacement battery can consistently supply for 20 hours at 68 °F (20 °C) while remaining above a specified terminal voltage per cell. as an example, a battery rated at 100 A-h can deliver 5 A over a 20-hour period at temperature. The fraction of the stored charge that electric battery can deliver depends on multiple factors, including battery chemistry, the speed at which the charge is delivered (current), the desired terminal voltage, the storage period, ambient temperature, and other factors.

Battery life is extended by storing the batteries at a coffee temperature, as during a refrigerator or freezer, which slows the side reactions. Such storage can extend the lifetime of alkaline batteries by about 5%; rechargeable batteries can hold their charge for much longer, depending upon the type. to succeed in their maximum voltage, batteries must be returned to room temperature; discharging an alkaline battery at 250 mA at 0 °C is simply half as efficient as at 20 °C.

- Inverter

Signal Generator

The PWM signal to be utilized in the circuit is produced by a microcontroller Atmega328. For the assembly of the PWM, 32 samples were picked. For calculating the worth of the duty cycle for the samples we use the formula Duty cycle = the sine of the corresponding angle x maximum duty circle. The corresponding angles are gotten by dividing the angle for the one-half cycle by the full number of samples. Assuming our maximum duty cycle is given as 250 then for the primary 16 samples. The 16 samples are then repeated to offer a complete of 32 samples, to create a half-wave at 50 Hz.

MOSFET Selection

In the H-bridge design, four MOSFETs are used on both sides of the bridge therefore ringing it all to a complete of sixteen MOSFETs. the most input current is given by:

$$I = \frac{power\ rating}{input\ voltage}$$

So either side of the bridge should be ready to carry a maximum current of 125 Amps. For this design, the MOSFET IRFP260n was chosen, having a maximum rating of 40 Amps. Four of the MOSFETs where paralleled together on both sides, in order that the input capacity is now 160 Amps. this can be enough to handle this sufficiently.

DC-Link Capacitor Selection

the utmost ripple voltage is when the duty cycle is at 50% in order that the most peak to peak ripple voltage is given as:

$$\Delta V_{0.5t} = V_{bus} / (32 \times L \times C \times f^2)$$

Choosing an allowable 1% for the ripple voltage we are able to calculate the DC link capacitor value. 1% of the bus voltage is 0.2.

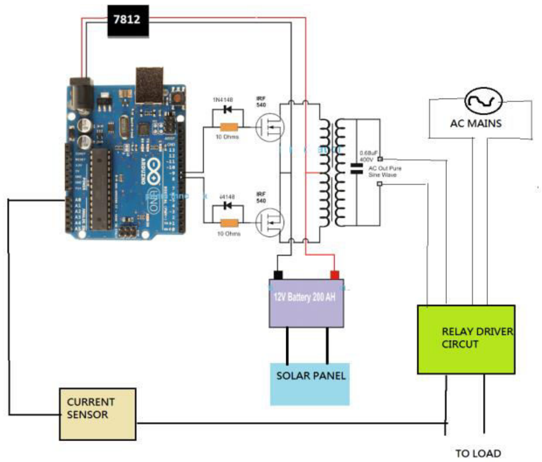
Re-arranging

$$C = \frac{Vbus}{32 \times l \times \Delta V_{0.5t} \times f^2}$$

Output Filter

The final component necessary to output a pure wave signal is an output filter. For this work, we used an L-C low pass filter. this may filter all the surplus noise above the critical frequency. The goal for this can be to bring the critical frequency as close as possible to the specified frequency of fifty Hz, removing other harmonics that occur within the system.

$$C = \frac{Vbus}{32 \times l \times \Delta V_{0.5t} \times f^2}$$



IV. CONCLUSIONS

A microcontroller-based smart inverter circuit that generates a pure sine waveform was developed and tested. The circuit, built around an ATMEGA328 microcontroller, was designed and simulated with Proteus Software, programmed with MicroC Software, so constructed on a computer circuit board. The circuit when tested produced a 230 V r.m.s 50 Hz undulation with very low harmonics distortion which makes it suitable for powering inductive loads like microwaves and motors making then run faster, quieter and cooler. It also reduces audible and electrical noise in fans, fluorescent lights, audio amplifiers, TV, fax, and answering machines. It prevents crashes in computers, weird print outs, and glitches in monitors. From the test applied and results obtained the system performed in line with the look specification Hence, the target was realized. The proposed system is economic, efficient, and reliable and may be used for the medium still as high power applications.

REFERENCES

[1] Economy of India, November 2016 [Online]. Available: https://en.wikipedia.org/wiki/Economy_of_Nigeria. [Accessed on March 04, 2017]

[2] India Power Baseline Report, September 16,2015 [Online]. Available: India_energy_power_report_final.pdf. [Accessed on March 04, 2017]

[3] J. Abolarinwa and P. Gana, "Design and Development of Inverter with AVR using Switch Mode Square Wave Switching Scheme," Assumption University Journal, vol. 13, no. 4, pp. 249-257, April 2010.

[4] G. Irving, "Power Supplies: Switching Regulators Inverters and Converters" first. New Delhi: BPB Publications, 1985.

[5] Funso, A. O. Micheal and A. Stephen, "On Various Oscillators and Power Amplifier Design Methods Employed for the Development of Power Inverters." International Journal of Research and Reviews in Applied Sciences, Vol. 5, no. 3, (2010).

[6] Gana, J. Aboluwarin and Paul. "Design and Development of Inverter with AVR Using Switch mode Square Wave Switching Scheme" Assumption University Journal, pp. 249-257, 2010.

[7] M. Abdelati, and G. Frey, "A Method for Building a Simple Congress on Energy Efficiency and Energy Related Materials. Springer International Publishing, 2015 pp. 357-367.

[8] Hann, James H. "Modified Sine-Wave Inverter Enhanced."Power Electronics Technology, 2006.

[9] Ample Power Company. "Microwave Ovens and Quasi-Sine Wave A.C. [Online]. Available: https://amplepower.com/pwrnews/micro2/index.htmlJ. [Accessed on March 05, 2017].

[10] O. A. Komolafe and I. Olufemi, "Gapped Alternate Phased Opposite Disposition Pulse Width Modulation Control for Multilevel Inverters,"Journal of Engineering and Applied Sciences, vol. 9, no. 4, pp. 560-567, 2014