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Study of Grid Tied Inverter

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ABSTRACT: Grid Tied Inverter play an important role in interfacing critical loads such as computers, communication systems, medical/life support system and industrial controls to the utility power grid. Grid tied inverter offers AC voltage regulation on continuity basis which incorporates with the controllable battery charger. The battery used is Lead Acid Type battery. The charge control technique used for battery is constant voltage charging technique. AVR microcontroller is the heart of the system and controls entire system. By programming the microcontroller using embedded C, SPWM pulses to drive H-bridge are generated. By alternating switching switches of two legs of H-bridge alternating 12V DC voltage is converted into 12V Ac voltage. Output of H-bridge is given to step up transformer to step up the voltage to 220V, 50Hz.The microcontroller is so programmed that at every instant it checks the voltage that is supplied to the load through sensors. At any instant if it detects that there is over voltage, under voltage, microcontroller acts to isolate the load from the power source by sending tripping signal to relay. Once relay isolates the load from the power source, microcontroller supplies the load through the charged battery. Battery supplies the load until the power supply voltage reaches normal value of voltage.

KEYWORDS: Inverter, Microcontroller, LCD Display, Voltage sensor.

I. INTRODUCTION

Grid tied inverter is a power conditioner that provides power to a load when the mains voltage is not in specifications. In grid tied inverter , the load is connected to the inverter through a switch. When the AC main is available and voltage is under the specified limit the load is supplied from the grid. the rectifier circuit will supply the power to the battery and battery will be charged. If the supply voltage changes suddenly, the battery will supply power to the inverter without any interruption and delay.

A Grid tied inverter is inserted between the source of power (typically commercial utility power) and the load which is protected. When abnormality occurs, the Grid tied inverter will effectively switch from utility power to its own power source almost instantaneously. In grid tied inverter under normal operation, a small amount of power is being converted from AC to DC to maintain battery charge. When input AC power goes out of specification, the inverter converts the DC power to AC to support the load. When the input power goes out of specification, there is a power disturbance in output voltage as the power failure is detected, the relay operates, and the output inverter turns on to begin to supply the load.

II.METHODOLOGY

Block diagram of the proposed grid tied inverter system with over voltage, under voltage protection using AVR microcontroller is shown in fig1. The block diagram mainly consist of following important blocks. ATMega32 microcontroller: It acts as the heart of the system. It controls and monitors entire system. Microcontroller also takes care of the protection. It protects the load from over voltage, under voltage conditions by sending a tripping signal to relay.

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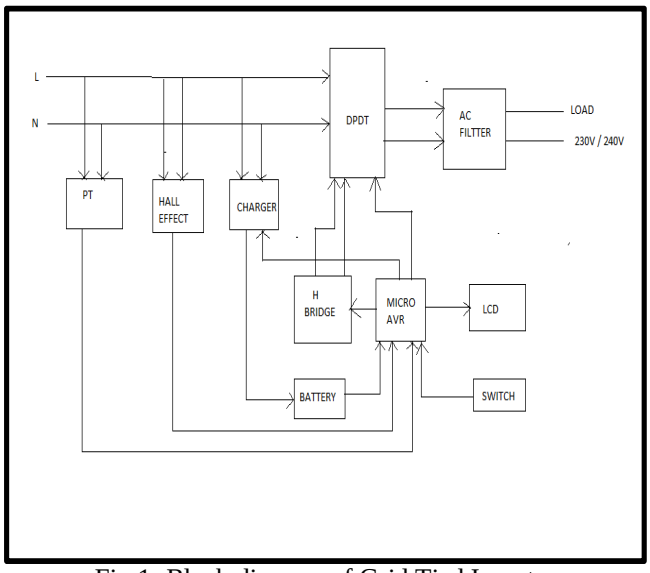

Fig.1- Block diagram of Grid Tied Inverter

After relay isolates the load from supply the load is now supplied from battery unit. Due to the fluctuations of energy sources, which impose stringent requirements for inverter topologies and controls. The function of an inverter is to change direct current (DC) input voltage to a symmetric alternating current (AC) output voltage of desired magnitude and frequency. When the main power is not available grid tied inverter uses batteries and inverter to supply AC power. A rectifier is used to recharge the battery used when the main power is back. Transformer is used to step up the voltage across the h-bridge to 220V.

III. MODES OF OPERATION

Normal voltage: In this operation mode the mains voltage is under the specified limit ,i.e. ± 5%. So the load will be supplied from the grid directly. Over voltage: In this operation mode the mains voltage is increased beyond the specified limit,i.e.±5%. The microcontroller is continuously observe the grid voltage as grid voltage increases above the specified limit microcontroller will ON the inverter. so the load will supplied by the inverter .the output voltage of inverter is 230v, so the load does not get affected by the grid voltage disturbance.

Under voltage: In this operation mode the mains voltage decreases below the specified limit . microcontroller now change the load from grid to the inverter so the load performance will not change as per the grid voltage .in this case the load is supplied from the inverter .

IV. COMPONENTS DESCRIPTION

1. Potential Transformer: A potential transformer is used for measurement of high voltage. Basically potential transformer is step down voltage transformer , so the high voltage can be easily measure by low rating voltmeter
2. Current sensor: The hall effect current sensor is used for measurement of load current. The current sensor chip used is ACS712ELC-05B. This current sensor can be measure plus or minus 30 amp, corresponding to the analog output of 185mV.
3. Battery Charger: Battery charger circuit is used for charging the battery. The output of battery charger is 12v dc. The dc output is achieved from ac input source i.e. from the grid. The rectifier is used for converting ac into dc. The rectifier is non control diode rectifier.
4. H Bridge inverter : A example of an H Bridge and required control devices is shown in the diagram below. It includes the four required MOSFETs needed for a complete H Bridge, two gate drivers for each side of the bridge with the associated boot strap capacitors, and an Arduino Uno used to create the PWM signals that are fed into the gate drivers. There are two different DC sources, one for the Arduino at 5 Volts DC, one for the gate drivers at 15 Volts DC. All power supplied share the same common ground.

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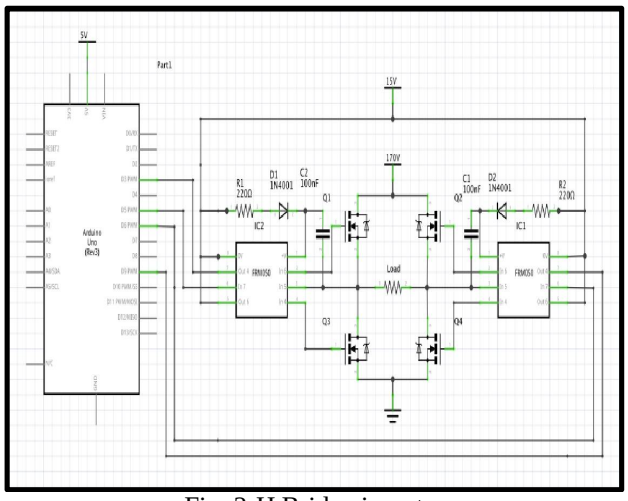

Fig .2-H Bridge inverter

5.Battery: The battery used is Lead Acid Type battery. The charge control technique used for battery is constant voltage charging technique. The battery is used 12v ,7AH, max initial current 1.4A.

6.AC filter: A resistor–capacitor circuit (RC circuit), or RC filter or RC network, is an electric circuit composed of resistors and capacitors driven by a voltage or current source. A first order RC circuit is composed of one resistor and one capacitor and is the simplest type of RC circuit. In this circuit arrangement, the reactance of the capacitor is very high at low frequencies so the capacitor acts like an open circuit and blocks any input signals at Vin until the cut-off frequency point (fc) is reached. Above this cut-off frequency point the reactance of the capacitor has reduced sufficiently as to now act more like a short circuit allowing all of the input signal to pass directly to the output

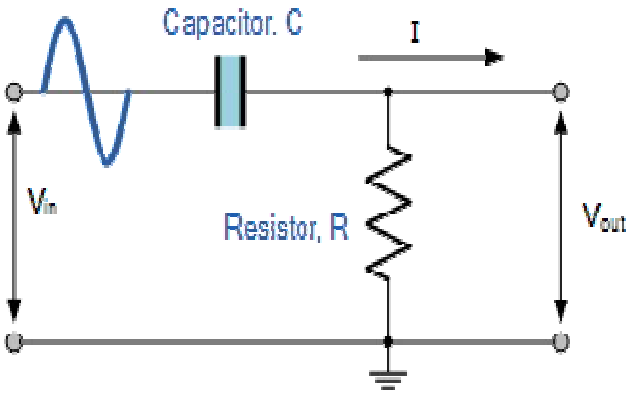

Fig.3.AC filters

7. 16*2 LCD Display: It is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly.LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements

8. Microcontroller : Basically, ATmega16 is an 8-bit AVR microcontroller. We used RISC architecture which have 131 powerful instruction set. The maximum limit of ATmega working frequency is 16MHZ which are executed in one machine cycle. Every single clock cycle of 1MIPS per MHZ. Due to these it is 10 times faster than the CISC controller. Normally, ATmega is of 40 pin and 4 ports. Rather than other micro-controllers like 8051 and PIC18, AVR16 provides better power platform, greater coding efficiency and low expenditure.

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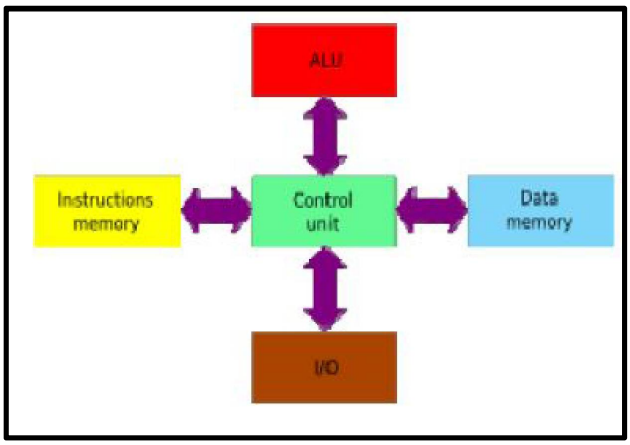

Fig.4: AVR microcontroller

VI. CALCULATIONS

Design of 100 Watt Inverter, assuming efficiency of the inverter to be 98%

Efficiency = P_o / P_{in};
P_{in} = P_o/0.98; =100/0.98;
P_{in} = 102 Watts;

Where, Pin = DC input power to the inverter = Vdc * Idc; Po = AC output power of the inverter Since the input DC voltage (Vdc) is varied from 12.5-14V, the range of input DC current (Idc) is 8.16A to 6.5A.

Assuming the output power factor of the inverter to be 0.8; Therefore the output power of the inverter,

(Po) = Vrms * Irms * cosϕ;

Since the output voltage of the inverter (Vrms) = 220V;
The output current of the inverter (Irms) = 0.5Amps.

VII. FUTURE ENHANCEMENT

We completed our project successfully with the available sources. But the results and modifications are not up to the expectations. This can be further improved by incorporating the following modifications to obtain better results.

A. Design of inverter with sinusoidal pulse width modulation technique.
B. SPWM technique having output waveform of pure sine wave. Also harmonics filtration can be done by this technique.
C. Used of parallel source of power to the inverter like solar panel which will increase the efficiency.

VIII. CONCLUSION

The grid tied inverter is operated in three operating modes and maintaining the output voltage constant. So the load does not affected by the grid voltage fluctuations, the characteristics and performance does not change with respect to the grid voltage .the three operating modes are normal voltage ,over voltage. The grid tied inverter can be used to interfacing critical loads such as computers, communication systems, medical/life support system and industrial controls to the utility power grid.

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