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Design of Solar Power Inverter

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Abstract: The high energy demand and the constant depletion of the fossil fuels lead us to shift our focus to renewable energy sources which are not only the future unlimited source of energy, it is also eco-friendly and viable for the environment. Solar energy is the oldest form of Renewable Energy. This paper focuses on the design of Solar Inverter which is required to run AC loads which is mostly used as consumable purpose. The power output of the designed inverter is 100W, input voltage is 12V ,Output is 220 V, 50Hz square wave output.

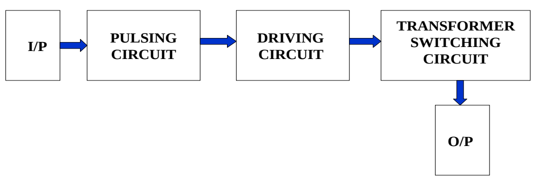
Keywords: Fossil fuels, AC, DC

INTRODUCTION

The need of running AC Loads on solar energy leads us to the design of Solar Power Inverter.. Since the majority of modern conveniences all run on 220 volts AC, the Power Inverter will be the heart of the Solar Energy System. It not only converts the low voltage 12 volts DC to the 220 volts AC that runs most appliances, but also can charge the batteries if connected to the utility grid as in the case of a totally independent stand-alone solar power system. These are special inverters which are designed to draw energy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid.

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Solid-state inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.

SCHEMATIC DIAGRAM OF INVERTER CIRCUIT-



The inverter circuit consists of 3 sections, namely,

- SECTION A- Pulsing circuit
- SECTION B- Driving circuit
- SECTION C- Transformer switching circuit

SECTION A (PULSING CIRCUIT)

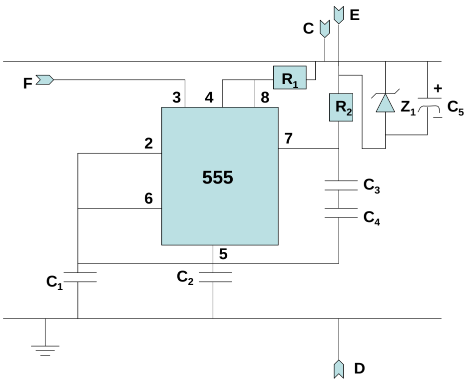


FIG: PULSING CIRCUIT OF INVERTER

PULSING CIRCUIT

The 555 Timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation and oscillator applications.

1. Here the 555 timer is acting as a monostable multivibrator. In the above diagram the CTRL reference voltage is supplied by capacitor C2. The triggering voltage is being set by capacitor C1.
2. The pin no 3 is connected to +Vcc.
3. The reset pin (pin no 4) and the pin no 8 is used to drive the transistor Q2 of the driving circuit. Fig(2P)
4. As pin no 7 is the discharge pin a zener diode (Z1) and a capacitor (C5) is used to maintain the voltage. The pulse generated by the 555 timer is sent to the driving circuit through the path C, D, E and F.
5. Monostable multivibrator often called a *one shot* multivibrator is a pulse generating circuit in which the duration of this pulse is determined by the RC network connected externally to the 555 timer. In a stable or standby state, the output of the circuit is approximately zero or a logic-low level. When external trigger pulse is applied output is forced to go high (» V_{CC}). The time for which output remains high is determined by the external RC network connected to the timer. At the end of the timing interval, the output automatically reverts back to its logic-low stable state. The output stays low until trigger pulse is again applied. Then the cycle repeats. The

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monostable circuit has only one stable state (*output low*) hence the name *monostable*.

The **internal diagram for a 555 timer** acting as a monostable multivibrator is shown in the figure-

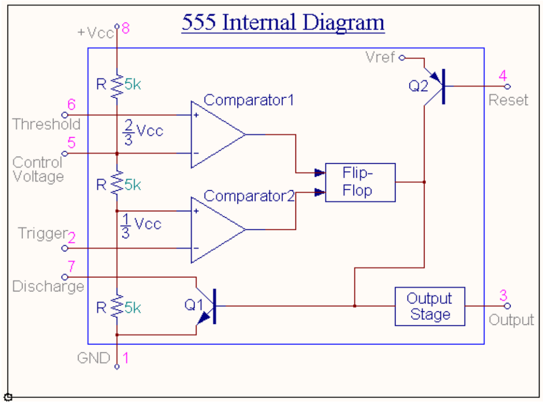


FIG : INTERNAL DIAGRAM OF MULTIVIBRATOR

PIN	NAME	PURPOSE
1	GND	Ground, low level (0 V)
2	TRIG	OUT rises, and interval starts, when this input falls below 1/3 V_{CC}
3	OUT	This output is driven to $+V_{CC}$ or GND.
4	RESET	A timing interval may be interrupted by driving this input to GND
5	CTRL	"Control" access to the internal voltage divider (by default, 2/3 V_{CC})
6	THR	The interval ends when the voltage at THR is greater than at CTRL.
7	DIS	Open collector output; may discharge a capacitor between intervals.
8	V+,VCC	Positive supply voltage is usually between 3 and 15 V.

SPECIFICATIONS OF 555TIMER:

Supply voltage (V_{CC})	4.5 to 15 V
Supply current (V_{CC} = +5 V)	3 to 6 mA
Supply current (V_{CC} = +15 V)	10 to 15 mA
Output current (maximum)	200 mA
Maximum Power dissipation	600 mW
Power Consumption (minimum operating)	30 mW@5V, 225 mW@15V
Operating Temperature	0 to 70 °C

SECTION B (DRIVING CIRCUIT)

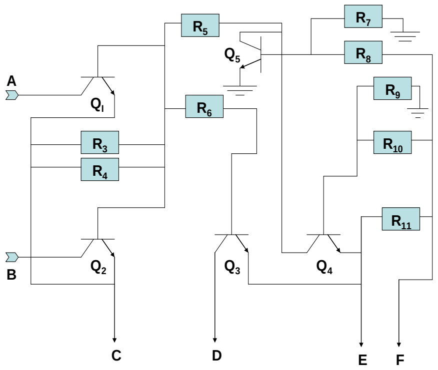


FIG : DRIVING CIRCUIT OF INVERTER

DRIVING CIRCUIT

This driver circuit is basically required as the voltage received from the inverting transistors is not sufficient to drive the transformer which has a higher rating. The power transistors are connected to heat sink for better dissipation of heat.

1. It basically consists of two transistors-two SL100 (Q1 and Q2) which basically produces square wave output.
2. Another transistor 147B (Q5) is used to invert one square wave output so that we get a full wave square output.
3. The resistances R11 and R7 are used for setting the reference voltages of transistors Q4 and Q5 respectively.
4. Resistance R9 and R10 are used to limit the base current of transistor Q4 and R8 is used to limit the base current of transistor Q5.
5. Then this square wave is basically send to two pair of power transistors (Q6, Q7 and Q8, Q9) via two resistances R12 and R13 which is basically the driver circuit of the transformer.
6. A diode (D1 and D2) is connected to each pair or power transformer to maintain the unidirectional flow of the current.

SECTION C (TRANSFORMER SWITCHING CIRCUIT)

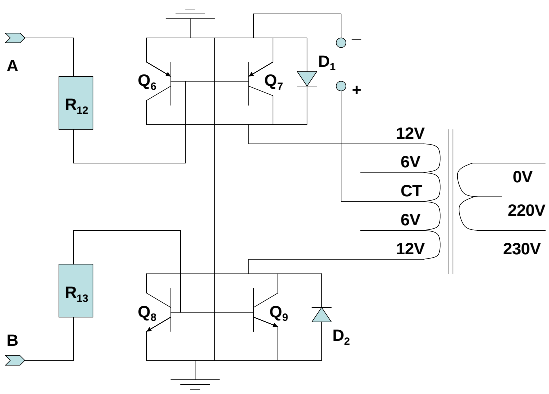


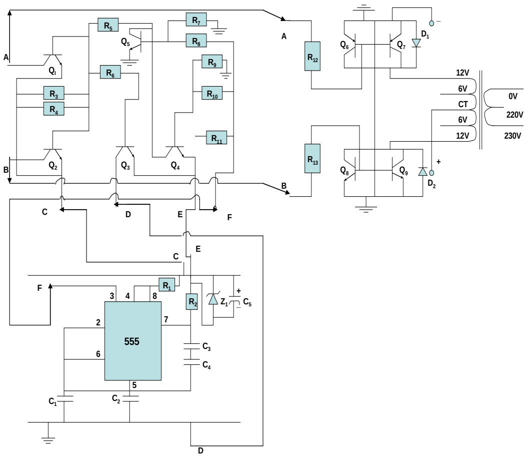
FIG : TRANSFORMER SWITCHING CIRCUIT OF INVERTER

TRANSFORMER SWITCHING CIRCUIT

1. The output of the driving circuit (A and B) is fed to the transformer switching circuit.
2. Then the output pulse is fed to the power transistor pair (Q6-Q7 and Q8-Q9) via resistances (R12 and R13).
3. The resistances basically limit the base current of the power transistors. The emitters of the power transistors are grounded.
4. The diodes (D1 and D2) are connected to each pair or power transistors to maintain the unidirectional flow of the current. .
5. The power transistors are connected to heat sink for better dissipation of heat.
6. When the pulse is fed through A then the upper region of the primary coil of 12-0-12 transformer which produces the output voltage (220 volts) on the secondary side.
7. When the pulse is fed through B then the lower portion induces the output voltage on the secondary side thus give the alternating character to the output voltage received.

The transformer is basically required to get a 220v output. The transformer basically used here is 12-0-12 charger type push pull connected transformer.

The circuit diagram for the Solar Inverted is:



PROTECTIVE FUNCTIONS OF THE SOLAR INVERTER USED IN OUR PROJECT-

A. **Overloading Protection:** When the power consumption of the appliance/appliances exceeds the total power of the solar inverter, it will then revert to the protection state within 20 seconds until you reduce the load.

B. **Short circuit protection:** If an appliance short circuits, the solar inverter will revert to the protection state until the appliance is removed.

C. **Thermal protection:** If the temperature of the solar inverter gets too hot it will revert to the protection state until it is turned off to cool down.

D. **Reverse polarity protection:** If connected incorrectly no current will pass through the solar inverter (The hand of the voltage meter will point to the reverse direction).For that purpose a diode (IN5408) is connected to the positive terminal of the inverter.

CONCLUSION

The output received by the inverter is basically square wave and not a sine wave. The square wave has an edge over sine wave because for lighting a tube light we don't require a choke for square wave unlike sine wave which reduces the cost.

REFERENCES

[1] Basset E. D and Potter F. M., "Capacitive Excitation for Induction Generators," AIEEE committee of Electrical Engineering, 1935, pp 535 - 545.

[2] C. F. Wanger, "Self-Excitation of Induction Motors," AIEE Trans., Vol. 58, 1939, pp. 47-51.

[3] E. Barkle and R.W. Ferguson, "Induction Generator Theory and Application," AIEE Trans., pt. III A, Vol. 73, 1954, .pp.12-19.

[4] Barkle and Perguson, "Induction Generator Theory and Application," AIEEE committee of Electrical Machinery, 1954, pp 12 - 19.

[5] Novotny D.W., Gritter and Studtman, "Self-Excitation in Inverter Driven Induction Machines", IEEE Transaction on power apparatus and system, Vol. PAS-96, No. 4, 1977, pp 1117 - 1125.

[6] Arrillaga, J. and Watson, D. B. "Static Power Conversion from Self-Excited Induction Generators," IEE Proc. Vol. 125, No.8, 1978, pp 743 - 746.

[7] S. S. Murthy, O. P. Malik, and A. K. Tandon, "Analysis of self excited induction generator," Proc. Inst. Elect. Eng. C, vol. 129, no. 6, Nov. 1982, pp. 260-265.

[8] R. C. Bansal, "Three-Phase Self-Excited Induction Generators: Over View," IEEE Transaction On Enrgy Conversion, vol. 20, No.2, June 2005, pp. 292 - 299.

[9] G. Raina and O. P. Malik, "Wind Energy Conversion Using A Self-Excited Induction Generator," IEEE Trans. Power App. Syst., Vol. PAS -102, no. 12, 1983, pp. 3933-3936.

[10] R. Bonert and G. Hoops, "Stand Alone Induction Generator withTerminal Impedance Controller And No Turbine Controls", The IEEE Energy Development and Power Generation Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1989 Summer Meeting, Long Beach, California, pp 28 -32, July 9 - 14,1989.

[11] R. Bonert and S. Rajakaruna, "Self-Excited Induction Generator with Excellent Voltage and Frequency Control", in Proc. IEE Generation, Transmission & Distribution, Vol. 145, No. I., pp 31 -39, January I998.

[12] S. S. Murthy, Rini jose and Bhim Singh, "A practical load controller for stand-alone small hydro system using Self- Excited Induction Generator", in Proc, IEEE, pp 359 - 364, 1998.

[13] Bhim Singh, S. S. Murthy and Sushma Gupta, " An Improved Electronic Load Controller for Self-Excited Induction Generator in Micro-Hydel Applications", in Proc. IEE, pp 2741 -2746, 2003.

[14] Bhim Singh, S. S. Murthy and Sushma Gupta, "Analysis and Design of Electronic Load Controller for Self-Excited Induction Generators" IEEE Transactions on Energy Conversion, Vol. 21, No. 1,. pp 285 - 293, March 2006

[15] Bhim Singh, S. S. Murthy and Sushma Gupta, "Transient Analysis of Self-Excited Induction Generators with Electronic Load controller supplying static and Dynamic loads,"

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IEEE Transactions on Industry Applications, Vol. 41, No. 5, , pp1194 -1204, September 2005.

[16] Yogesh K., Chauhan, Sanjay K. Jain, and Bhim Singh (2010). A prospective on voltage regulation of self-excited induction generators for industry applications, IEEE Transactionss on Industry Applications, Vol. 46, No.2, pp 720-730.

[17] Bhim Singh, S. S. Murthy and Sushma Gupta, "Analysis and Design of Electronic Load Controller for Self-Excited Induction Generators" IEEE Transactions on Energy Conversion, Vol. 21, No. 1, March 2006, pp 285-293.

[18] Karim H. Youssef, manal A, Wahba, Hassan A. Yousef and Omar. A.Sebakhy, " A new method for voltage and frequency control of Standalone self-excited induction generator Using PWM converter with Variable DC link voltage", IEEE conference, 2008 American Control Conference Westin seattle Hotel, Seattle, Washington, USA, June 11-13, 2005, pp.2486 -2491.

[19] R. Bonert and S. Rajakaruna, "Self-Excited Induction Generator with Excellent Voltage and Frequency Control", in Proc. IEE Generation, Transmission & Distribution, Vol. 145, No. I., pp 31 -39, January I998.