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INVERTERS AND THEIR WORKING

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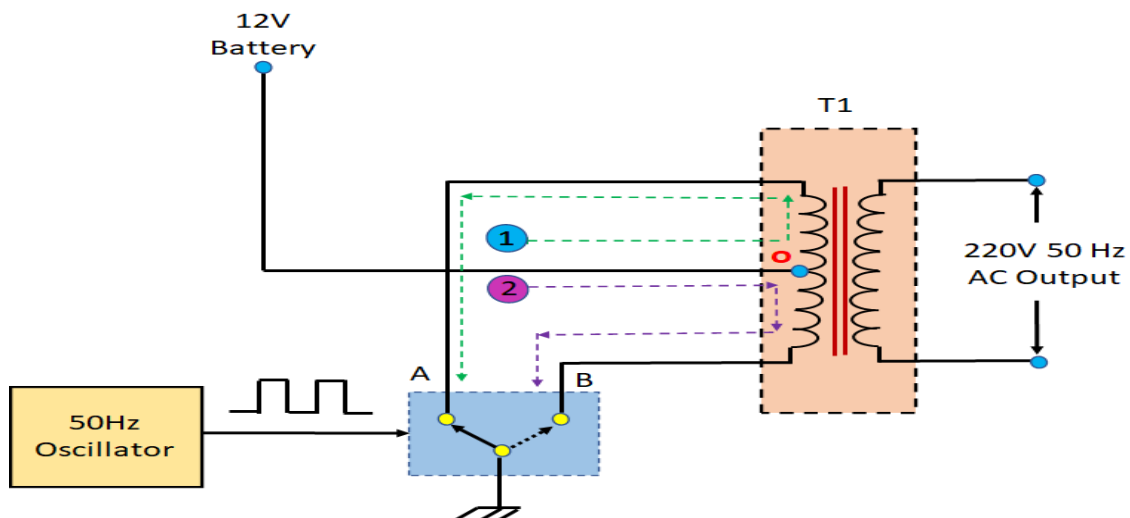
ABSTRACT: An inverter, is a power electronics device which used to convert fixed DC (Direct Current) into controlled AC (Alternating Current)". Here, Controlled AC means we controlled two parameter of AC signal Frequency and Amplitude. In other words, the inverter is a static device. It can convert one form of electrical energy into other forms of electrical energy. But it cannot generate electrical power. Inverter takes DC power from the batteries and converts into AC power at the time of the power failure. In inverter we use some power semiconductor switching devices like IGBT, MOSFET, GTO because these devices having self-commutation property. A power inverter convert bulk DC power into AC power and used in the power system network. For example power inverters are used at the receiving end of HVDC transmission lines. This inverter is known as a grid-tie inverter.

KEYWORDS: inverter, AC, DC, power, frequency, amplitude, commutation, grid-tie, transmission

I. INTRODUCTION

Before inverter, DC (Direct Current) to AC (Alternating Current) conversion is done with the help of a motor-generator set and rotary converter. The term inverter was first introduced by David Prince titled "The Inverter" in 1925. Prince defined the inverter as the "Inverse of a Rectifier". The basic function of inverter is to convert DC power into AC power, while at the same time regulating the voltage, current and frequency of the signal. Basically, Inverter is a kind of oscillator.

- Transistors are the key components of inverter, which convert DC power into AC power.
- IGBT, MOSFET are the most commonly used switches in inverter.
- How many numbers of switches we use depends on the type of inverter?
- The transistor is used to change the steady voltage and one-way current flow of DC to the constantly changing voltage and oscillating current of AC.
- The key feature of the transistor in the generation of AC power is that it can rapidly switched on or off. [1,2,3]



Here we see in the circuit diagram here we use 12V battery, one transformer (Primary winding of transformer is Center tapped), One two-way switch and 50 Hz oscillator. Here 12V battery generate DC supply and inverter will change it into, AC supply of 220V, 50Hz to use to operate any appliances.

The 12V DC supply from the positive terminal of the battery comes to the primary winding of transformer which is center tapped. The two ends of the primary winding of transformer (A and B point) are connected to the two-ways switch to the ground. If the switch connects to A point of the primary winding. The current flows from the battery into upper half of primary winding (o) through A contact of the switch to the ground. If switch turn from A point into B point. This time the current number 1 stops flowing. Then, the current 2 flows to the ground through o and contact B of the switch.

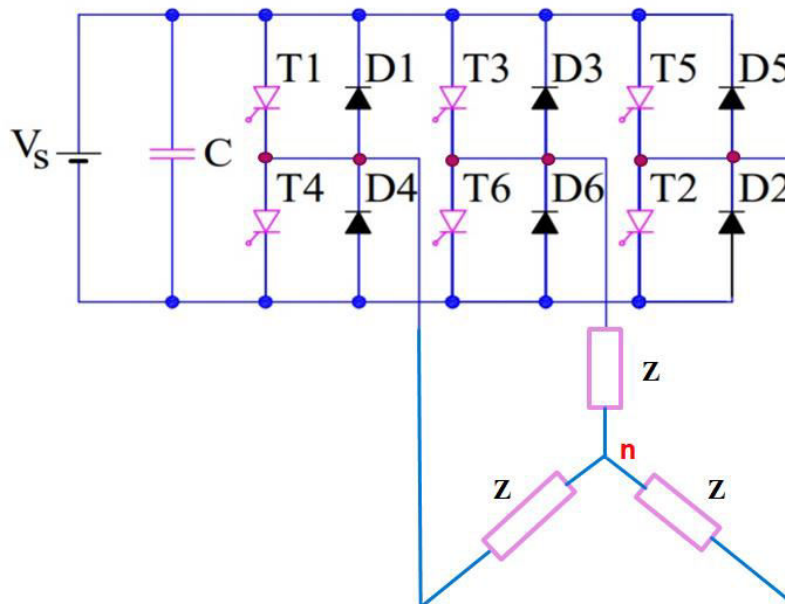
Here, 2 ways switch is controlled with the square wave oscillator it generates a frequency of 50 Hz. It causes the switch to selects between A and B point with speed about 50 times per second. Also, the current 1 and 2 flows to the transformer alternately at a rate of 50 times per second. So, the current flows into the transformer alternately look like AC voltage.

We know that transformers work on the principle of Electromagnetic induction. When current flow in primary winding EMF induced and a current will be induced into the secondary winding of transformer. Which it causes AC voltage 220V 50Hz. Now, the voltage is use to be supplied to the various types of electrical equipment that operate in 220 Volt AC supply.[5,7,8]

II. DISCUSSION

Applications of Inverter

- When the AC main power supply is not available, an uninterruptible power supply (UPS) uses battery and inverter.
- Power inverters are basically, used in the HVDC transmission line. It also used to connect two asynchronous AC systems.
- The output of the solar panel is DC power. The solar inverter used to convert DC power into AC power.[9,10,11]



Three phase inverter

Three phase Inverter convert a DC voltage into three phase AC voltage. In industrial application three phase inverter are more commonly used than single phase inverter. Such as three phase inverters are basically used for variable-frequency drive applications and for high power applications (like HVDC power transmission).

Three phase inverters basically consists of three single-phase inverter switches each connected to one of the three load terminals.

A three phase inverter is also known as six-step bridge inverter. Here, step is defined as a Switching sequence of SCR or firing from one SCR to the next SCR in a sequence. For getting one complete cycle of 360° , each step is of 60-degree interval. This means, thyristors will be turned on at a regular interval of 60-degree in a sequence. So, that three phase AC output voltage is synthesized at its output.[12,13,15]

To achieve high voltage, current and power ratings inverter, two three phase six inverter can be connected in series for higher voltage rating and two three phase six inverter can be connected in parallel for higher current rating. In both the cases, the output waveforms are 12-step waveform.

Classification of Three Phase Inverter :

Three Phase Inverter are classified in two types:

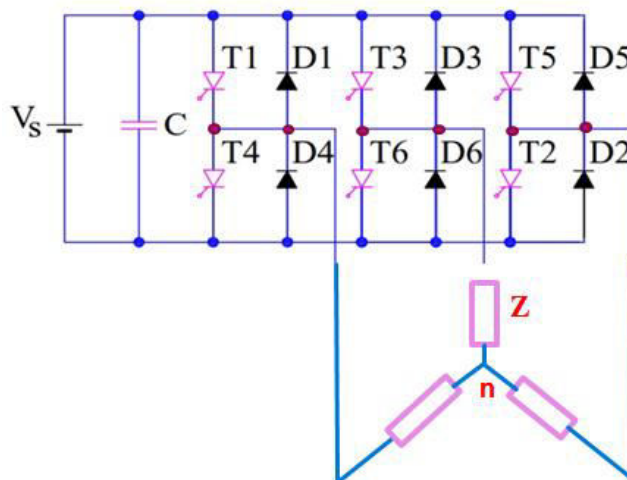
1. 180-degree conduction mode
2. 120-degree conduction mode

The circuit diagram for both the conduction modes are same.[17,18,19]

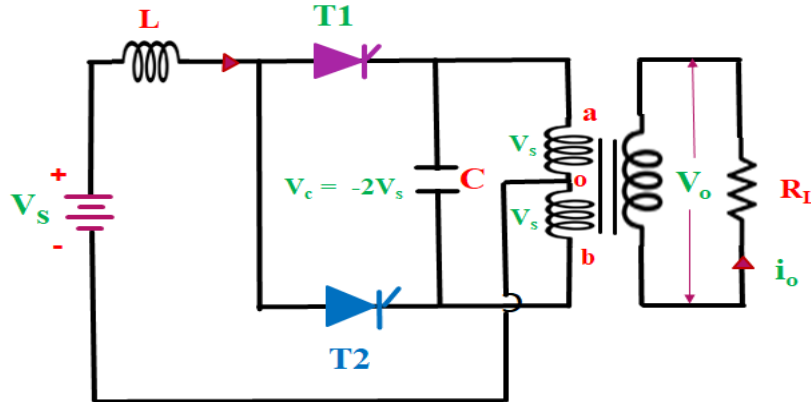
Circuit Diagram of Three Phase Bridge Inverter:

The circuit diagram of three phase bridge inverter consists of minimum of 6 SCR and 6 diodes. Here a large capacitor is connected at the input side in parallel with V_s to make input DC voltage constant. This capacitor reduces the

harmonics feedback to the source. The three-phase inverter is assumed to be star connected.



Three Phase Inverter Circuit Diagram

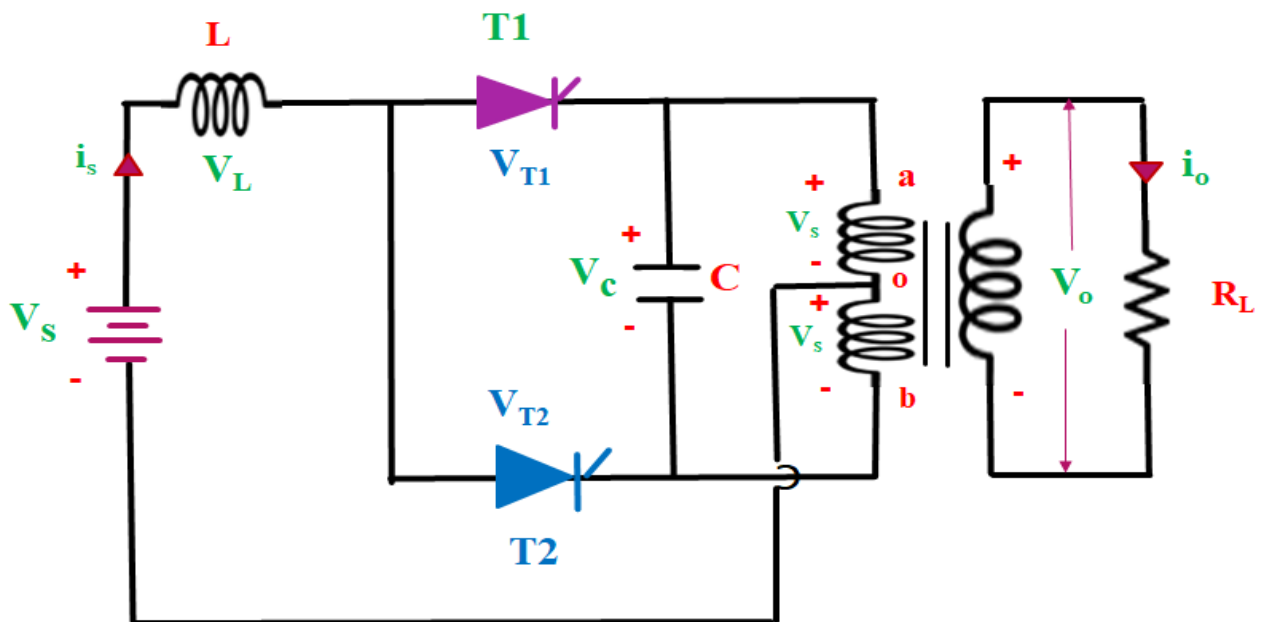


Parallel Inverter: It's Basics, Operation and waveform

Inverter is an electronic circuit which converts DC power into AC power. The inverter circuit in which the commutating component C (capacitor) is connected in parallel with the load via transformer called a parallel inverter. This circuit is also called Push-pull inverter.

Parallel Inverter working is similar to the class B commutation. Parallel inverter has important role in Uninterrupted Power Supply (UPS).

Parallel inverter circuit consist of two thyristor T1 and T2, a transformer, inductor L and a commutating component C. Capacitor (C) is connected in parallel with the load via transformer therefore it is called a parallel inverter. And inductor (L) is connected in series with supply to make the source current constant. Here we also use a center -tapped transformer. Centre tapping is done in the primary winding of transformer so, primary winding is divided into two equal halves ao and ob.

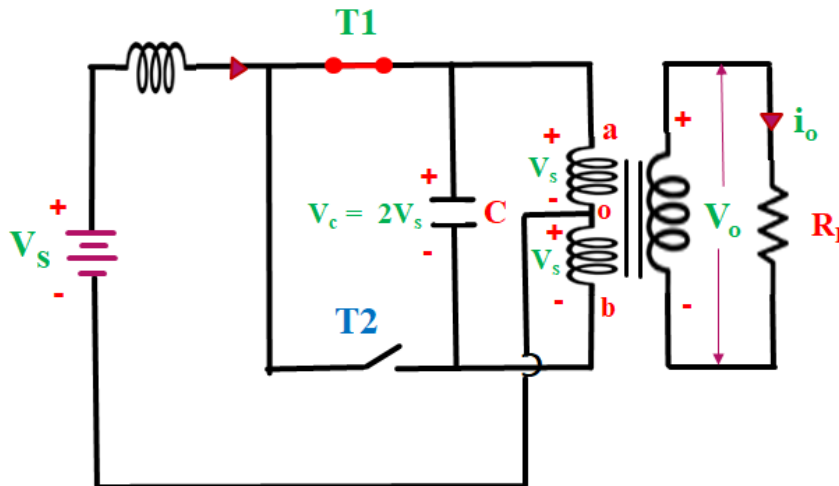
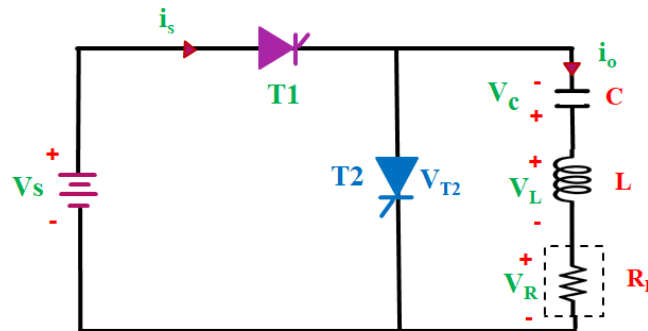


Circuit Diagram of Parallel Inverter
 Operation of Parallel Inverter:

The operation is divided into four modes:

Mode I ($0 < t < t_1$): In this mode we give firing pulse to thyristor T1 and T1 get turned on and T2 is turned off. Current flow from Supply V_s T1.... a_o (upper half of primary winding) back to V_s . As a result, V_s voltage is induced across upper as well as lower half of the primary winding of transformer. And V_s voltage is induced in secondary winding.[19,20]

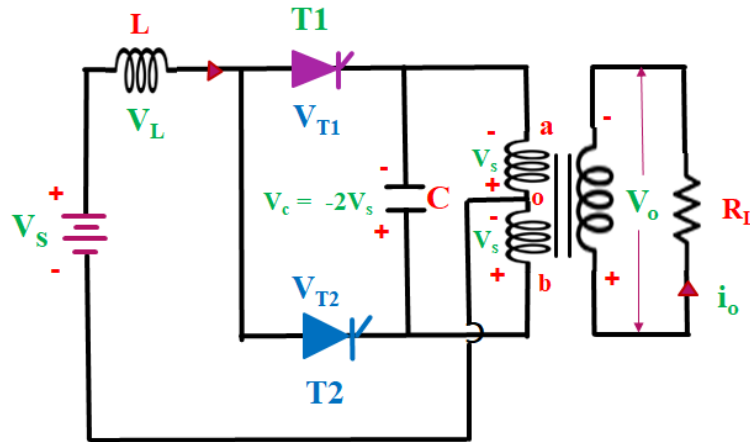
III. RESULTS



Mode I – Operation where T1 ON and T2 OFF
 So, output voltage across load is V_s .

So, the total voltage across primary winding is $2V_s$. Here capacitor is connected in parallel with primary winding therefore capacitor charge with $2V_s$ voltage with upper plate is positive and lower plate is negative.

Mode II ($t_1 < t < t_3$): In this duration we give firing pulse to thyristor T2 and T2 get turned on. At this time capacitor start discharging through T1 therefore T1 turned OFF. This time current flow from supply V_s T2.... b_o (lower half of primary winding) back to V_s .

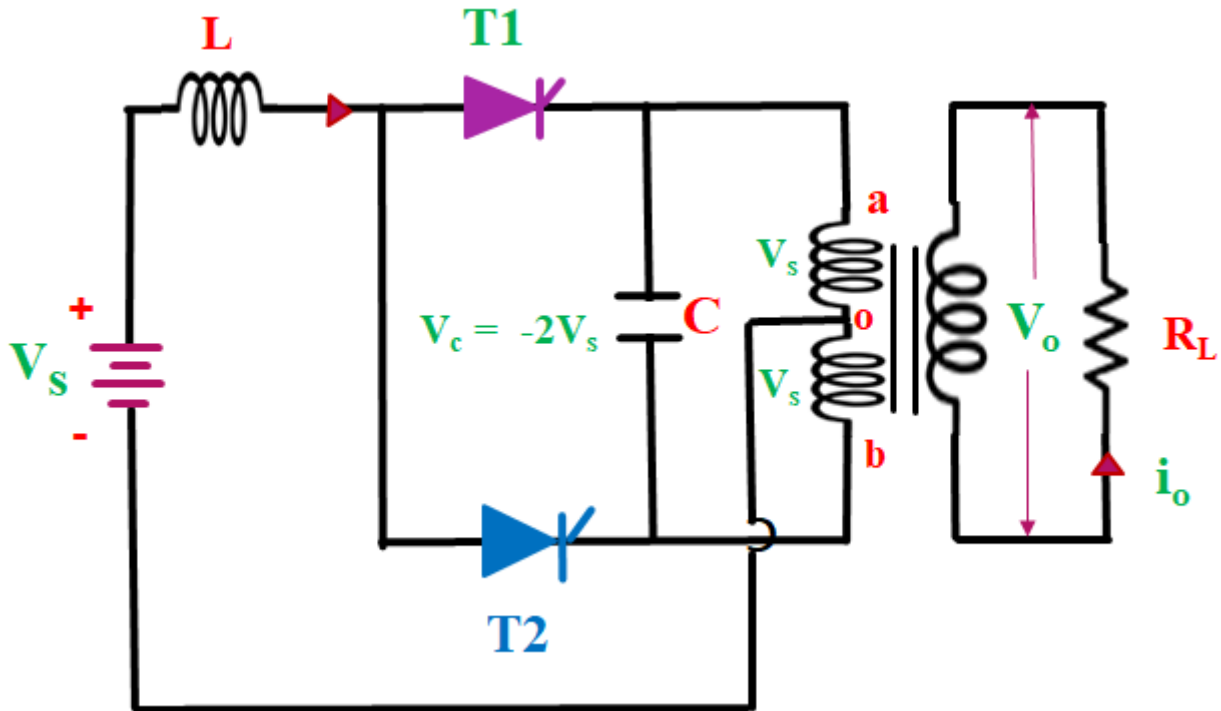


Mode II – Operation

Now this time capacitor charged with upper plate is negative, from $+2V_s$ at $t=t_1$ to $-2V_s$ at $t=t_2$. Load voltage also changes from V_s at $t=t_1$ to $-V_s$ at $t=t_2$. After $t=t_2$ voltage across capacitor is maintain constant $-2V_s$ between $t= t_2$ to t_3 .

So, load voltage is also constant $-V_s$.

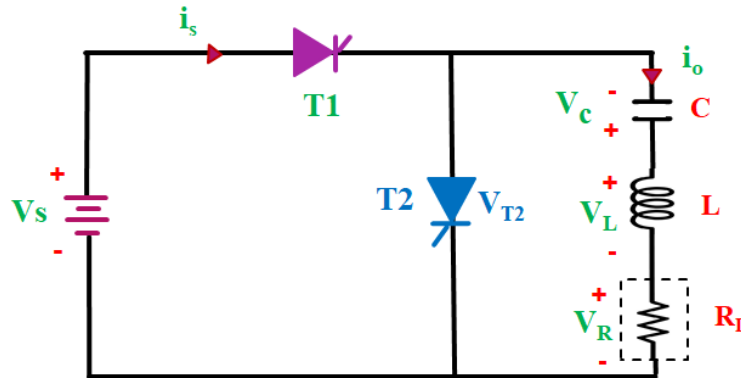
Mode III ($t_3 < t < t_4$): In this mode again, we give firing pulse to thyristor T1 and T1 get turned on. At this time capacitor start discharging through T2 therefore T2 turned OFF. This time current flow from supply V_s T1..... ao (upper half of primary winding) back to V_s . So, the total voltage across primary winding is $2V_s$. [17,18]



Mode III – Operation

Now this time capacitor charged with upper plate is positive, from $-2V_s$ at $t=t_3$ to $+2V_s$ at $t=t_4$. Load voltage also changes from V_s at $t=t_3$ to $-V_s$ at $t=t_4$.

So, output voltage across load is V_s .



Series Inverter: It's working, Operation and Waveform

Inverter is an electronic circuit which converts DC power into AC power. The inverter circuit in which the commutating elements L and C are connected in series with the load to form an under damped circuit is called a series inverter. This circuit is also called load commutated or self-commutated inverter.

This circuit is called load commutated inverter because the load component (L and C) is responsible to turned off the thyristor. It is called self-commutated inverter because in this circuit anode current itself become zero resulting the thyristor turned off.

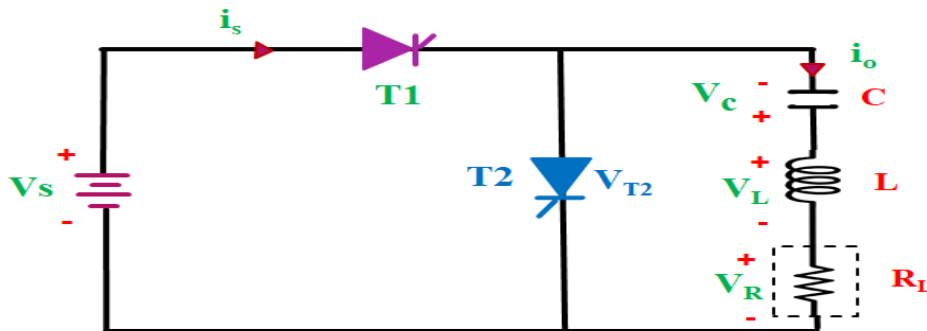
The operation of series inverter is similar to Class A commutation.

Series inverter is operating at high frequency 200 Hz to 100 KHz. Therefore the size of the commutated component is small. Here, the value of L and C is choose in such a way the R, L & C forma underdamped circuit.

Circuit Diagram of Series Inverter

The Circuit Diagram of Series Inverter is shown in the figure. It consists of two thyristors (T1 and T2). The thyristor T1 and T2 are turn on appropriately to get the output voltage of desired frequency. This circuit consist of L and C connected in series with load (R).

Initially we considered that thyristor T2 is turned off and the polarity across capacitor is shown in figure.



Series Inverter Circuit

Operation of Series inverter

The whole operation is divide into three modes:

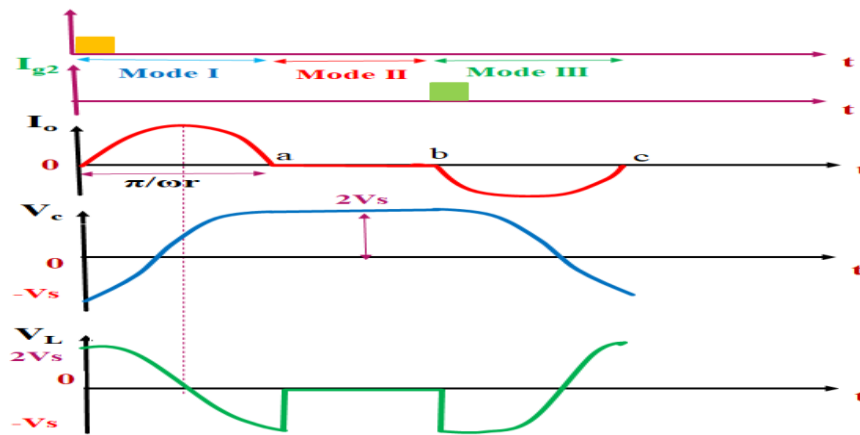
Mode-I (T1 on and T2 off): In this mode we give firing pulse to thyristor T1 so, T1 get turned on and T2 thyristor is turned off initially. So, current flow from supply V_sT1.....load.....back to V_s . [15,17,18]

The nature of the load current is alternating due to under damped circuit. So, this time capacitor (C) start charging gradually from $-V_s$ to its max voltage. This time inductor (L) also get charge. When the load current becomes maximum the voltage across capacitor becomes $+V_s$. When the load current becomes zero at point a the voltage across capacitor becomes $+2V_s$. Then the load current becomes zero the thyristor T1 automatically turns off at point a.

Mode- II (T1 and T2 both off): This time thyristor T1 turns off because the load current becomes zero from point a to b. In this time duration The thyristor T1 and T2 are turned off and voltage across capacitor becomes equal to $+2V_s$.

Mode III (T1 off and T2 on): In this mode we give firing pulse to thyristor T2. So, T2 get turned on. In this time capacitor start discharging its energy from $+2V_s$ to $-V_s$ through thyristor T2 and R – L circuit . Due to capacitor discharging reverse current flow across the load. Now at point C thyristor T2 turns off automatically due to load current becomes zero. The thyristor T2 turns off during point C to D and thyristor T1 again turns on. In this way cycle repeat.

Now, we see in the waveform the time duration ab and cd is called as dead zone.



Voltage and current Wave form of Series Inverter 1) I_{g1} is the gate pulse of thyristor T1 2) I_{g2} is the gate pulse of thyristor T2 3) I_o (output current) 4) V_c (capacitor voltage) 5) V_L (Load voltage)

Application of Series Inverter

Series Inverter is basically used in high frequency applications (200 Hz to 100 KHz) because it generate high frequency sinusoidal waveform.

- It is used in Induction heating.
- For Fluorescent lighting.
- Used in Sonar transmitter.
- Used in Ultrasonic generator.[17]

IV. CONCLUSIONS

Single Phase Full Bridge Inverter is basically a voltage source inverter and it is a topology of H-bridge inverter used for converting DC power into AC power. In case of Single Phase Half Bridge Inverter, we require three wire DC input supply. [18] Where as in Single Phase full Bridge Inverter we use two wire DC input supply, which suffices the requirement. By controlling the turn ON and turn OFF time of the thyristors output frequency can be easily controlled. Single phase full bridge inverter circuit required more component for conversion than that used in single phase Half bridge inverters so, the cost of the circuit get increases. The full bridge inverter circuit basically consists of 4 feedback diodes and 4 controlled switches (like Thyristor, IGBT or MOSFET). Single phase Half Bridge Inverter circuit basically consist of four Thyristor and four diode these diodes are called feedback diode. Each diode is connected in anti-parallel with each thyristor. A voltage source and a RL load. [19,20]

REFERENCES

1. The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition, IEEE Press, 2000, ISBN 0-7381-2601-2, page 588
2. ^ "Inverter frequently asked questions". www.powerstream.com. Retrieved 2020-11-13.
3. ^ How to Choose an Inverter for an Independent Energy System
4. ^ a b The importance of total harmonic distortion, retrieved April 19, 2019
5. ^ "E project" (PDF). www.wpi.edu. Retrieved 2020-05-19.
6. ^ Stefanos Manias, Power Electronics and Motor Drive Systems, Academic Press, 2016, ISBN 0128118148, page 288-289
7. ^ Stefanos Manias, Power Electronics and Motor Drive Systems, Academic Press, 2016, ISBN 0128118148 page 288
8. ^ Barnes, Malcolm (2003). Practical variable speed drives and power electronics. Oxford: Newnes. p. 97. ISBN 978-0080473918.
9. ^ "Inverter Basics and Selecting the Right Model - Northern Arizona Wind & Sun". www.windsun.com. Archived from the original on 2013-03-30. Retrieved 2011-08-16.
10. ^ Tripp Lite: Power Inverter FAQ, <http://www.tripplite.com/support/inverter-faq>
11. ^ "Inverter Battery Capacity Calculator & Easy To Follow Formula". InverterBatteries.in. 2020-03-15. Retrieved 2020-07-22.
12. ^ "New and Cool: Variable Refrigerant Flow Systems". AIArchitect. American Institute of Architects. 2009-04-10. Retrieved 2013-08-06.
13. ^ "Toshiba Science Museum : World's First Residential Inverter Air Conditioner". toshiba-mirai-kagakukan.jp.
14. ^ Du, Ruoyang; Robertson, Paul (2017). "Cost Effective Grid-Connected Inverter for a Micro Combined Heat and Power System" (PDF). *IEEE Transactions on Industrial Electronics*. 64 (7): 5360–5367. doi:10.1109/TIE.2017.2677340. ISSN 0278-0046. S2CID 1042325.
15. ^ Mark (2019-11-27). "What is a Solar Generator & How Does it Work?". *Modern Survivalists*. Retrieved 2019-12-30.
16. ^ Unruh, Roland (Oct 2020). "Evaluation of MMCs for High-Power Low-Voltage DC-Applications in Combination with the Module LLC-Design". 22nd European Conference on Power Electronics and Applications (EPE'20 ECCE Europe). pp. 1–10. doi:10.23919/EPE20ECCEurope43536.2020.9215687. ISBN 978-9-0758-1536-8. S2CID 22223518.
17. ^ Kassakian, John G. (1991). Principles of Power Electronics. Addison-Wesley. pp. 169–193. ISBN 978-0201096897.
18. ^ a b c d James, Hahn. "Modified Sine-Wave Inverter Enhanced" (PDF). *Power Electronics*.
19. ^ "MIT open-courseware, Power Electronics, Spring 2007" (PDF). mit.edu.
20. ^ Rodriguez, Jose; et al. (August 2002). "Multilevel Inverters: A Survey of Topologies, Controls, and Applications". *IEEE Transactions on Industrial Electronics*. 49 (4): 724–738. doi:10.1109/TIE.2002.801052. hdl:10533/173647.



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