VOLTAGE HARMONICS REDUCTION USING MULTI LEVEL INVERTER : A REVIEW

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Abstract : In this paper method is illuistrated that how by using the multilevel inverter can be utilised to reduce the voltage harmonics in the system. In this method the output voltage of the inverter is modified from the square wave to the stepped wave by using several inverters in cascade called as the multilevel inverter. The method proves to be very useful in power systems having the photovoltaic generation. With the advancement of the power electronic devices this is easily achievable. The open loop control methodology is illustrated in this paper. The open loop strategy is easy to be implemented and thus proves to be simple and economical.

Keywords : Multlevel Inverter, Open Loop Control, Cascaded Inverter,harmonic reduction

Introduction : Energy is the primary concerns in the modern world. The country's economy primarily depend upon the availability of energy in the country. India is a vast country with huge population. The demand of energy in the country increases day by day. With several energy efficiency movements energy is saved but still the demand of energy is increasing day by day. To cope up with the ever increasing demand of energy many researches are going on harnessing the renewable energy.

One of the methods by which revewable energy can be utilised to produce electrical power is the photovoltaic system. In the photovoltaic system the light energy from sun is converted into electrical energy by using photo voltaic cell. The electrical energy output from the photo voltaic system is of DC (direct current) nature and of small value. The net power of the photovoltaic generation is increased by connecting several photo voltaic cells in series and parallel according to the voltage and power output requirement of the grid.

One of the problem associated with the photovoltaic generation is that the ouput power of the photovoltaic system is a DC. The loads at the consumer levels are AC loads. This problem can be overcome if all the loads are changed to DC loads but it is uneconomical. Another way of using this power to to convert the power into alternating power by using inverters.

The inverters utilise power electronic devices to convert dc input power to ac output power. Due to the use of switching devices (power electronic devices) the inverters tend to generate harmonics and the harmonics in the power system causes many problems like overheating of the devices, derating of the devices, reduction in power factors etc.

Several researches introduces the methods to reduce the curent harmonics by using pulse width modulation control or hysterisis control etc. This paper introduces the method to reduce the voltage harmonics from the output of the inverter. By this all the current harmonics at the load centres will automatically be eliminated.

Photovoltaic module model : a photovoltaic module consits of various small solar cells which are basically a spectial type of P-N junction diode fabricated in a wafer of semiconductor. As it is known that in evcry P-N junction there is a formation of depletion layer which produces depletion voltage. In solar cells when photons are emmited over the P-N junction then the depletion potential gets increased. By this way photons from sunlight in converted to electrical energy. The equivalent circuit of a solar cell is as shown in the figure 1

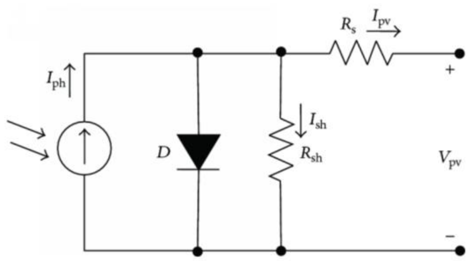

Fig 1 Equivalent Circuit of A Solar Cell

Here I_{ph} is the photon current, R_{sh} is the intrinsic shunt resistance of the cell, R_s is the intrinsic series resistance of the cell. Here R_{sh} and R_s have very high and very small value respectively hence for analysis these can be neglected. The ouitput voltage V_{pv} depend upon the amaount of photon emmited into the solar cell.

Multilevel Inverter : In the synchronous motor we do distributed winding to create a stepped wave flux in the core. The same concept is employed in the multilevel inverter. In a classical inverter for an H bridge inverted one H bridge is connected across the dc source. One H bridge consists of two legs having two fully controlled switch in each leg and one switch of each leg is triggered simultaneously to obtained square wave output. The schematic diagram of a H bridge inverter is shown in figure 2

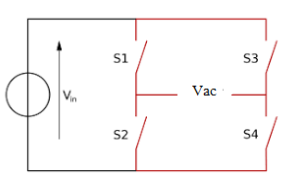

Fig 2 An H bridge inverter

As seeen in the diagram an H bridge inverter has 4 switches s1, s2 , s3 and s4. Out of these s1 and s4 are triggered simultaneously to obtain positive voltage at the output. S2 and s3 are triggered simultaneously to obtain the negative voltage at the output.

The input output voltage can be observed by figure 3.

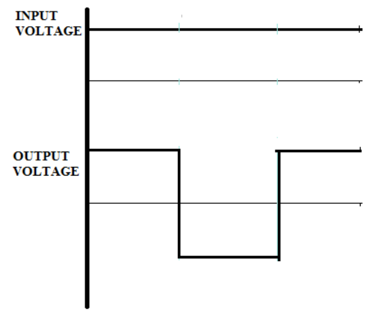

Fig 3 input and output voltage of a H- bridge inverter.

As seen from the figure the output voltage is a square wave. This contains many harmonic components which is not desired. To element these voltage harmonic components one method can be using several H bridge in cascade such that the output voltage is a stepped wave. This makes a multilevel inverter. The harmonic compents in a stepped waveform is very less. Thus the total harmonic distortion can be reduced to a great extent using multilevel inverter. The circuit diagram of a 5 level multilevel inverter is shown in figure 4

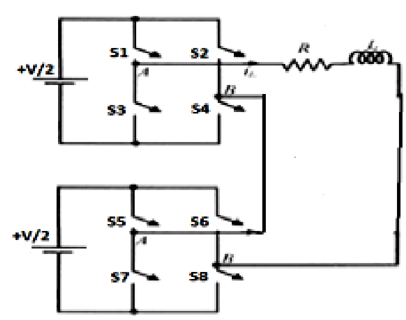

Fig 5 circuit diagram of 5 level multilevel inverter.

As shown in the figure 5 there are two H bridge connected in cascade. The input to both the H bridge is half of the total input voltage. As the number of h bridge in cascades are increased the total input voltages are equally divided among all the H bridge. The operation of the multilevel can be explained by figure 5. Here there are 4 switches in each

H bridge the switching pattern can be done accordingly to obtain different level of voltages.

1. When s3,s4, s7 and s8 all the switches are triggered then there occurs a short circuit across the load and the output voltage is zero.
2. When s1,s4,s7 and s8 are triggered then the circuit is completed through only upper H bridge thus in this case the output voltage is V/2.
3. When s2,s3,s7 and s8 are triggered then circuit is completed for negative cycle thus the output voltage is –V/2.
4. When s1,s4,s5 and s8 are triggered then the circuit completes through both the H bridge for positive voltage. Hence the total output voltage in this case is V.
5. When s2,s3,s6, and s7 are triggered then circuit is completed through both the H- bridge for negative voltage. Hence the net output voltage in this case is –V.

To have maximum effect in reducing THD switching is done in such a manner that as the voltage level increases the time of triggering is also increased such that maximum voltage triggering is the highest. If the proper switching is done then the output voltagew waveform will be like as shown in figure 6.

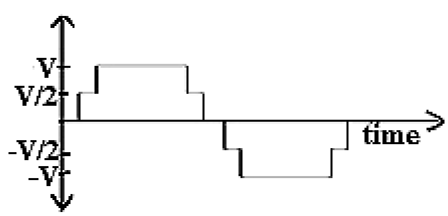

Fig 6 Output voltage of 5 level multilevel inverter

Discussion : From the waveform shown in figure 6 it is clear that the voltage harmonics can be eliminated by using the multilevel inverter. The figure shows the waveform of the 5 level inverter. By increasing the number of level of the multilevel inverter voltage harmonics can further be eliminated and the total harmonic distortion can be reduced to be below 5 %. The power having less voltage harmonics doent produce current harmonics and thus large amount of power can be saved and system can be prevented from overheating and derating.

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