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# Bidirectional Converter for high power applications Using Multi Junction Solar Cell

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**Abstract**

The main object of this paper is to achieve high quality sinusoidal output voltage with less Total harmonic distortion. This paper focuses on the behavior of Multi junction solar cell systems. The PV cells can offer better simulation results using multi junction solar cell. In a single-diode model still it require more improvements, thus multi junction solar is analyzed to get better and more accurate to produce maximum output. So Multi junction solar cell is compared with the conventional silicon PV cell to show better performance for power electronic devices. Multi junction solar cell can provide almost 3-times maximum power compared to the single solar cell. By connecting renewable energy source with the electric drives it needs advanced power electronics converter. Due to this proposed converter needed for high power and medium voltage situations. A universal bridge with filters will improves the performance of the system. A PWM technique is pursue for this converter to trigger the power devices. This converter reduces the sources, switches and increasing the level to improve the efficiency of the converter. This converter is used for high power and voltage applications. By reducing the switches power loss can be reduce in converters. MATLAB software is used to simulate the converter and FFT analysis is carried out to observe the Total harmonic distortion. This paper shows how to produce a suitable sine wave by using less number of semiconductor switches (MOSFET, MESFET, IGBT, GTO etc...).By PWM technique using MATLAB/SIMULINK software the operation and model of the proposed converter was designed by using less number of switches. The proposed circuit produces high efficiency and also less total harmonic reductions (THD) by the help of simulation..

**Keywords**: Total harmonic distortion (THD), PWM –pulse width modulation, Multi junction solar cell, Photo voltaic cell.

## Introduction

### 1. Multi junction Solar Cell:

One of the primary goals of solar cell design is to improve efficiency. Indium Gallium Nitride is a material that has undergone extensive research. By varying the composition of Indium Nitride and Gallium Nitride within Indium Gallium Nitride, the band gap of this semiconductor material can be changed. The band gap range of Indium Gallium Nitride matches closely the visible solar spectrum frequencies. Hence, a high-efficiency solar cell can be potentially developed by having several Indium Gallium Nitride junctions [1].

### 2. Classification of Materials

Materials can be categorized according to their electrical properties as conductors, insulators or semiconductors. The conductivity σ is a key parameter in identifying the type of material. Fig 1 presents a sample of materials based on conductivity. The pn diodes fall between the insulators and the conductors.

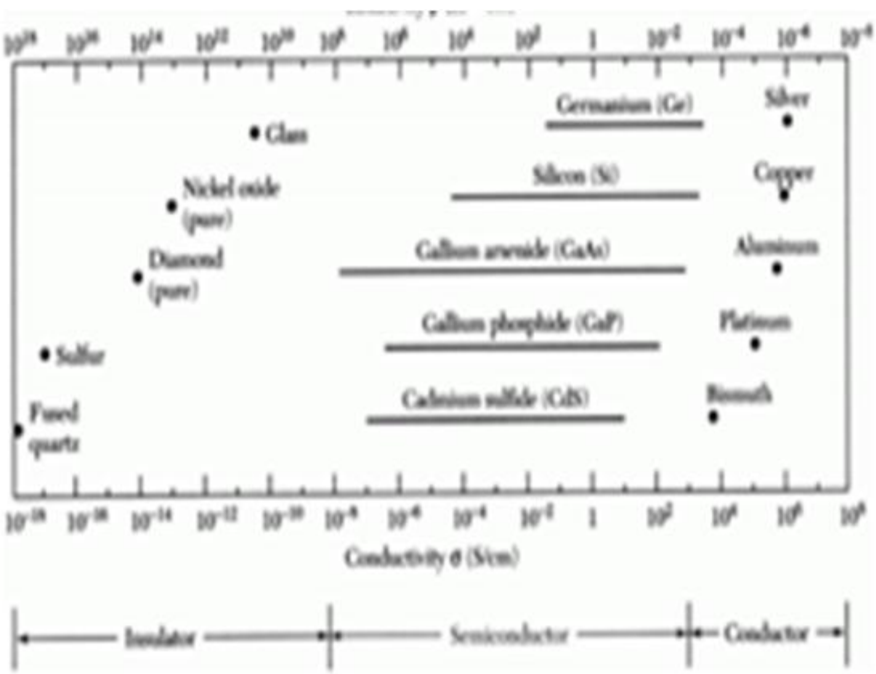


**Fig 1. Materials Classified By Conductivity**

The Electromagnetic Spectrum Light is electromagnetic radiation. The frequency of light determines its color. Fig.2 shows the visible part of the electromagnetic spectrum. VW range from 390 nm (violet) to 780 nm red.

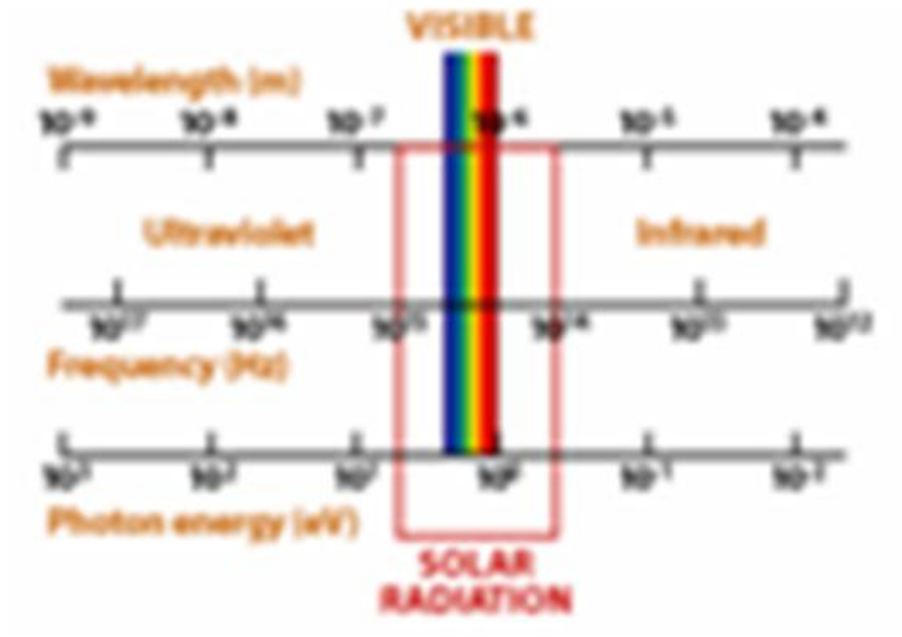


**Fig 2.Electromagnetic Spectrum**

**Table 1.Approximate Wavelength For Various Colour in Vacuum**

| Color | Wavelength (nm) |
|---|---|
| Red | 780-622 |
| Orange | 622-597 |
| Yellow | 597-577 |
| Green | 577-492 |
| Blue | 492-455 |
| Violet | 455-390 |

When light has energy greater than cut in voltage, the silicon PN junction generates electricity. Light < 1.1 eV of energy is unused. Similarly, light with energy greater than 1.43 eV excites the outer shell electrons of the gallium arsenide solar cell. And finally, light with energy greater than 1.7 eV is useful for aluminum gallium arsenide photovoltaic material.

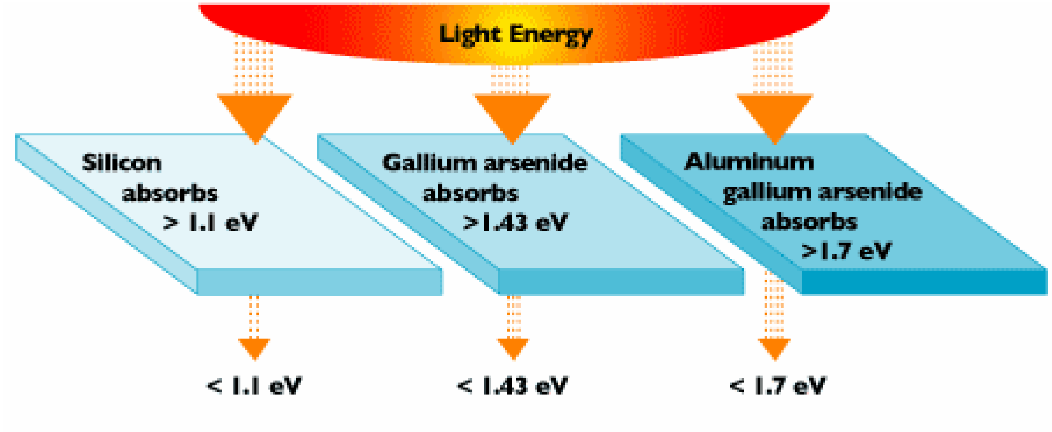


**Fig 3.Light energy for various solar cell**

### 3. Converter

The arrangement of four modules connected to a four input direct current to direct current boost converter [2]. So it can be designed for any number of modules. This configuration allows simpler gate drive circuit for the switches [3]. The single sub cell characteristics of an MJ solar cell system are given.

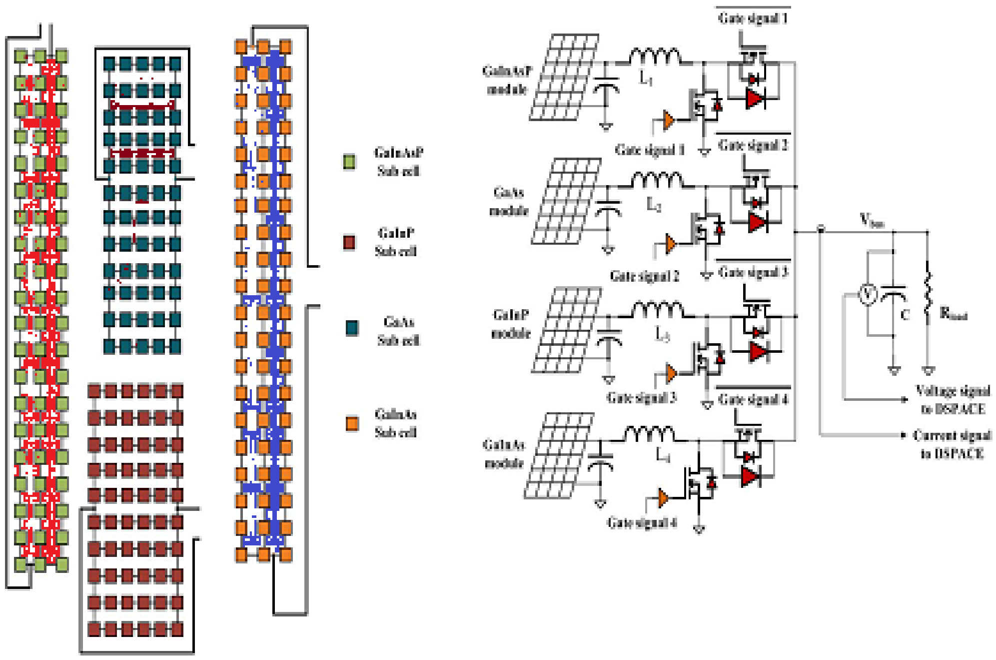


**Fig 4.Four Modules for four port converter**

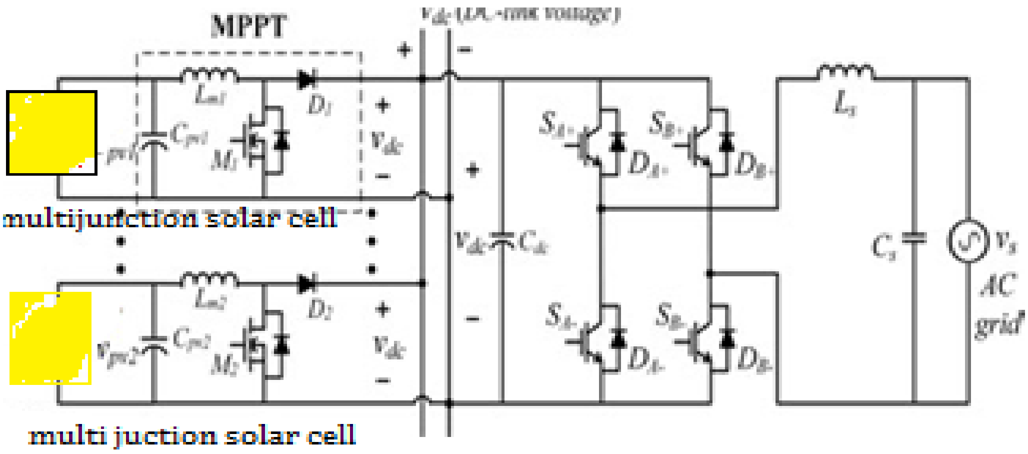


**Fig 5.General Converter circuit using MPPT with MJSC**

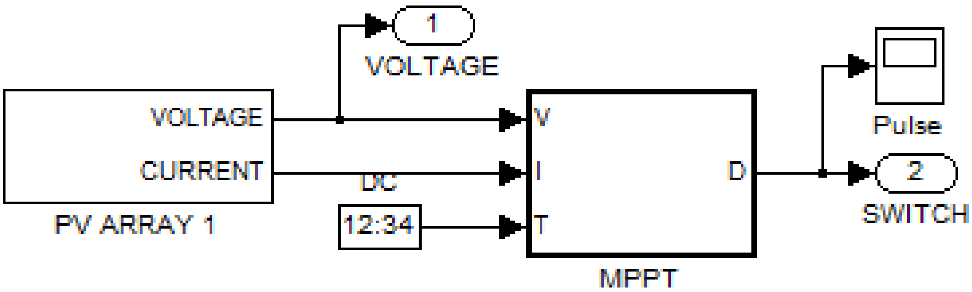


**Fig 6.Simulink –MPPT for single PV array**

**4. Soft Switching Techniques**

The hardware switch will have high switching losses during turn-on and turn-off processes, simultaneously the power device have to withstand high voltage and current, follow-on high switching losses and stress. The dv/dt and di/dt of the power devices can be reduced by adding the passive snubber to the power circuits, and the switching loss and stress be unfocused to the passive snubber circuits. Still, the switching loss is relative to the switching frequency, thus restrictive the maximum switching frequency of the converters. Still there is an EMI problem even though by adding stray inductance and capacitance in the power circuit. This L and C causes transient effect in the power circuit.Fig.5 shows the connection for general converter with MPPT tracking using multi junction solar cell. The major causes for electromagnetic interferencis the transient raising property.This paper shows by changing the power switches instead of MOSFET the IGBT will have high switching frequency and therby reducing the switching losses and also the total harmonic distortion can be reduced and by adding tank circuit the oscillatory is created in the power circuit by this it attains zero current switching and zero voltage switching. By allowing switching frequency typically 100 kHz to 500 kHz to the resonant converter to reduce the switching losses by improving the power semiconductor switche.By the help of zero current switching during turn on and turn off the switching losses can be eliminated and also can be reduce. As a relatively large capacitor is connected across the output diode for the period of resonance, the converter operation becomes thoughtless to the diode's junction capacitance. The major restrictions associated with ZCS when power IGBTs are used are the capacitive turn-on losses. There is lot of techniques used to reduce the switching losses in terms of increasing the switching frequency they are ZCS, ZVS, zero transient method and Voltage clamping method etc.,The mathematical analysis is less because it mainly depends upon only the operating principal and changing the parameters of the converters [4].The capacitive turn on losses can be reduced by zero voltage switching and it will helpful to produce proper high level frequency process.

## 5.EXISTING METHOD WITH HIGH THD

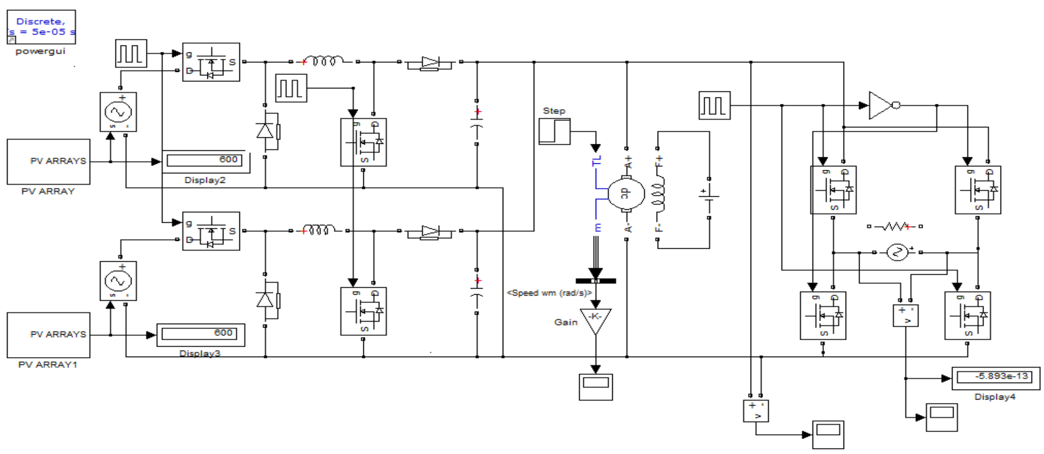


**Fig 5. Bidirectional converter using H-Bridge**

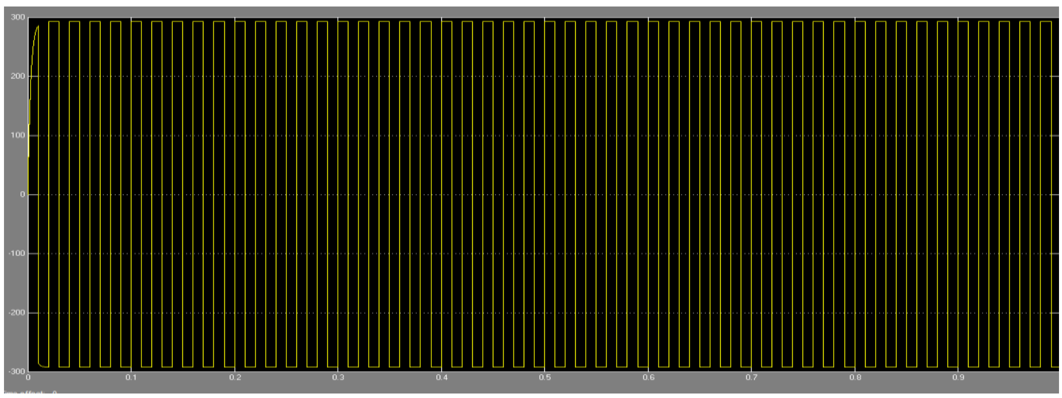


**fig 6.output wave form for the bidirectional converter**

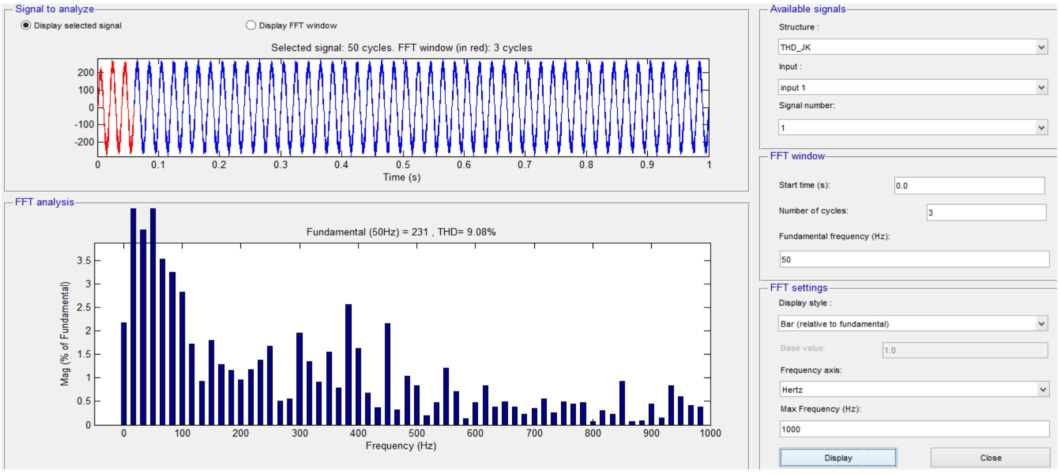


**Fig 7.Total Harmonic Distortion results**

This bidirectional converter is a full-bridge configuration, which can execute grid connection and rectification with power factor control [6]. The inverter senses dc-bus voltage vdc, line voltage, and inductor current iLs, and uses the variable inductance, which is a purpose of inductor current. The direct current bus voltage increases whenever there is increase in output power from PV arrays. By injecting the surplus power into ac grid by the help of grid connection mode.

## 6. PROPOSED SYSTEM

In proposed system, the prototype is altered to Universal Bridge and filters in order to simplify the converter circuit. In this work the reduced harmonic distortion can be achieved and by the topology of converters using PWM technique. In this topology a less number of power semiconductor switches is used by comparing the conventional cascade H- bridge cojnverter.Fig.8 shows the Simulation Diagram for universal bridge converter with MMPT tracking system. When the amplitude of carrier signal is less than the amplitude of the modulating signal the pulses are generated. The proposed converter has a better spectral quality and also has higher Fundamental output voltage without any pulse dropping [5].

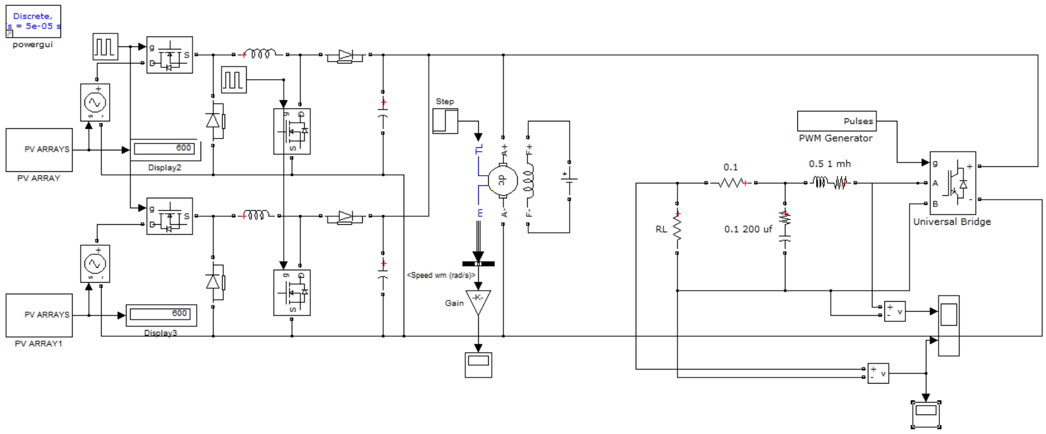


**Fig 8. Bidirectional converter using Universal Bridge**

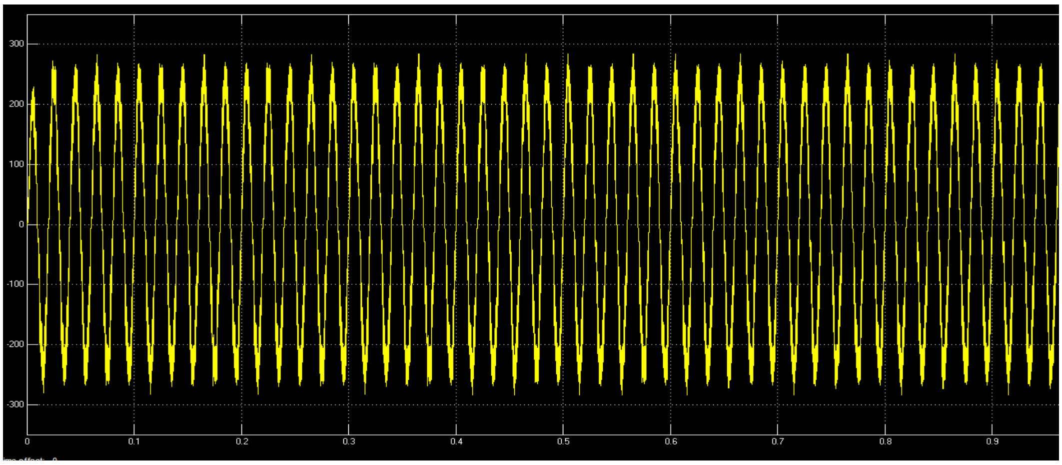

**Fig 9.Output wave form for the Bidirectional converter using Universal Bridge**

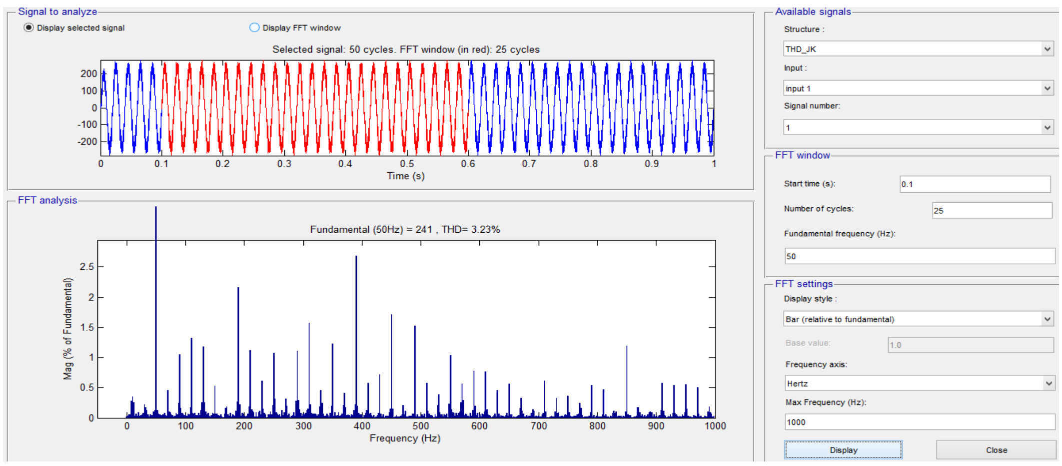


**Fig 10.Total Harmonic Distortion results**

An electrical converter can be called as a resonant converter based on resonant current fluctuation. In series resonant converter the resonating components and switching device are placed in series with the load. The current through the power electronic devices fall to zero due to the natural characteristics of the circuit. If the switching element is an IGBT, it is said to be self-commutated [7]. This type of converter produces an approximately sinusoidal waveform at a high output frequency, ranging beginning 20 kHz to 100 kHz, and is normally used in relatively fixed output applications, as induction heating, fluorescent lighting, or ultrasonic generators, sonar transmitters. When the switching frequency is high then the size of the resonating components is small.

**Table 2.Comparison Table for Cascade H-bridge and universal bridge with filters.**

| Types | OUTPUT VOLTAGE | THD |
|---|---|---|
| Converter –H-bridge(Existing) | Square wave(290.3V) | 9.08% |
| Converter with filters and universal bridge(Proposed ) | Sine Wave (300V) | 3.23% |

## 7. CONCLUSION

A new basic universal bridge with filters converter has been proposed. It has been shown that the structure, consisting of less number of power switches and thereby minimizing the circuit design and also improving the strength of output to the load. It has been shown that the proposed converter provides less THD and high efficiency proper output voltage. The proposed topology not only has less switches and components in comparison with other one, but also this converter operates using input as PV array by the maximum power point tracking system. Reduction of the power losses of the proposed topology is another advantage of the proposed converter. The proposed converter can be a good quality for applications that require high power quality. The simulation for the existing and proposed was done by using the MATLAB/Simulink. In this paper, different simulation model results are presented. The PV cells can operate at it maximum performance when there are minimum obstacles that shaded the PV cell or install it on the space ship devices, which are relatively closer to the sun. On the other hand, temperature of the cell can affect the *MPP* inversely. Double diode model is closer to real model of PV cell and it gives closer result between simulation and experiment tests. The MJSC tends to give a bright future in the solar cell industry but, the material provided in nature is still limited and some of them are not quit stable. Therefore, the MJSC is still be researched throughout this days. Installation of MPPT can be very useful, so whenever there is light, PV array can produce maximum power. Algorithm of constant voltage tracking method is necessary to get the best constant where voltage ratio can operate at the *MPP*. For closed loop control this proposed converter will produce high efficiency.

**8. Future work**

The system can be extended for more voltage range or levels. Increase in more levels wills sure increasing the voltage gain and efficiency of the converter system. The output AC Voltage can be use for the high voltage applications. Further the MJSC tends to give a bright future in the solar cell industry and also it will be suitable to combine the MPPT with this to get better efficiency.

## References

[1]. T. Salmi, M. Bouzguenda, A. Gastli and A. Masmoudi, "MATLAB/Simulink Based Modelling of Solar Photovoltaic Cell,"*International Journal of Renewable Energy Research,* 2012.

[2]. R.L. Steigerwald, “A comparison of half-Bridge Resonant converter topologies”, IEEE Trans on Power electronics, vol. 3, no 2, April 1988, pp.174-182.

[3]. J. D. M. Cambridge, M. A. Steiner, B. L. Unger, K. A. Emery, E. L.Christensen, and M. W. Wanlass *et al.*, “Compact spectrum splitting photovoltaic module with high efficiency,” *Prog. Photovoltaics: Res.Applicat.*, vol. 19, no. 3, pp. 352–360, May 2011.

[4.] Kang, D.W.; Hyun, D.S.; “Simple harmonic analysis method for multi-carrier PWM techniques using output phase voltage in multi-level inverter,” IEE Proc.,Electr. Power Appl., vol. 152, no. 2,pp. 157 - 165 , Mar. 2005.

[5] L. G. Franquelo, K. Gopakumar, S. Kouro, J. I. Leon, M. Malinowski, M. A. Pérez, J. Pou and B.Wu, J. Rodríguez. (2010)“Recent advances and industrial applications of multilevel converters”IEEE Trans. Ind. Electron, vol. 57, no. 8.

[6] Steiner, M., Scholten, J.: Energy Storage onboard of railway vehicles, 11th Europ. Conf. on Power Electronics, Dresden 2005

[7]. H. Choi, "Design Consideration of Half-Bridge LLC Resonant Converter", in Journal of Power Electronics, Vol. I, No. I, 2007, pp. 13-20