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CASCADED MULTILEVEL INVERTER

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ABSTRACT:

One technique, among many, to PV power more competitive is by developing economical and reliable inverters. The aim of this thesis is therefore to grow new and inexpensive concepts for converting electrical energy, from the PV module to the grid.Research has therefore been prepared in the field of inverter technologies, which is used to interface a single PV module to the grid. The inverter is developed with centre of attention on low cost, high reliability and mass-production

KEYWORDS : *inverter,technologies,grid,reliability,module*

1. INTRODUCTION

To perform this study, it was necessary to understand solar energy collection and its conversion into electricity, evaluation of electrical performance, and the current efforts being made to improve conversion efficiency. The primary material used in the modern collection of solar energy is silicon. Even though it takes 100 times more surface area of silicon than that of other solid-state materials to collect the same amount of energy, silicon was already developed and in mass production when solar energy collection technology was developed, and so it was the practical choice (Goetzberger, Luther, & Willeke, 2002) [12]. However, any semiconductor is acceptable. The semiconductor is part of a panel called a photovoltaic, or solar cell. This cell absorbs sunlight and transfers it into electricity, typically with a15-20% efficiency (A-M. Borbely)[13]. The true principle of this study (the factor observed) centers not on the inner processes involved in the energy transfer, but rather on the efficiency of the solar cell. The purpose of solar panels and solar energy collection is for the output of power, measured in Watts (P=V x I, V=voltage, I=current). However, in order to study how factors affect this output, it is crucial to understand how this performance is evaluated. A study was conducted by the Florida Solar Energy Center (1999) [14] observing the performance of two separate solar setups for homes in Kissimmee, Florida. Analyses were done on the long-term performance and efficiency of the two systems, measuring power over time in Watt-hours. This study examines similar parameters on a smaller scale, but does not look at many of the extra angles examined by this study. For example, the standard requirements of Electrical Codes had to be considered, which does not apply in this study. In essence, the Florida study was designed to incorporate all the elements necessary to practically supply a fully functional family home with all its electrical needs, whereas this study is more concerned with the general principles of solar energy collection. However, the most basic analyses are the same. The Florida study determined photovoltaics to be an adequate and acceptable alternative to standard electrical power. Kivalov Avezov’s study (2001) is another excellent look at evaluation of output. It examined thermal efficiency of solar panels, a factor not being considered in this study, but still presents sound examples of useful graphics, aptly demonstrated analysis equations, and a good explanation of what it all means.

2. THE PHOTOVOLTAIC MODULE

2.1 OPERATION OF PV CELL

A PV cell is essentially a large silicon PN junction (diode), Figure 3.1. The incoming of a photon makes the current flow: the PN junction has become a PV cell. The silicon atom contains four electrons in the outer shell. The electrons are a part of the electron pairs binding with four other silicon atoms. By doping the silicon with boron (p-doped), which has only three electrons in the outer shell, the silicon becomes electron deficit. Thus, a 'hole' is present in the silicon lattice, and positive charges may move around in the network. When doped with phosphorus (n-doped), which have five electrons in the outer shell, the silicon become electron saturated. These additional electrons are also free to move around in the lattice.

3. INDENTATIONS AND EQUATIONS

An internal field is being build and the electrons can no longer force the junction, thus the layers have reach equilibrium [58].

The amplitude of the built-in potential is:

$$\phi_i = \frac{k.T_{cell}}{q}.\ln\left(\frac{N_a.N_d}{n_i^2}\right) \tag{3.1}$$

Where N_a and N_d are the acceptor and donor doping densities correspondingly, and n_i is the intrinsic carrier density, which do not contain boron or phosphorus. The constant k is Boltzmanns ($13.8\text{x}10^{-24}$ J/K), q is the electron charge ($160\text{x}10^{-19}$ C), and T_{cell} is the absolute cell temperature.

An incoming photon may 'knock' off a carrier from the p-layer, which leaves a free hole, and the carrier is moving around in the p-layer. If the carrier reaches the PN junction before recombination, the internal field causes it to move into the n layer. On the other hand, the carrier may be a victim of recombination before it can reach the junction, thus it will not assist the current generation. Recombination is caused by irregularities in the lattice, impurities in the material, or simply coincidence! Once the electron has forced the PN junction, is has two possible return paths. The electron can either pass through the PN junction (which then works as a diode) or it can pass through an auxiliary circuit, the load.

The minimum energy required to release a carrier from the p-layer are in the span E_{gap} = 0.2 to 3.7 eV, which varies along with material, temperature, quantity of doping and layout of the PN junction. The empirical formula in (3.2) describes the band gap energy [59]:

$$E_{gap} = E_{gap(0)} - \frac{\alpha.T_{cell}^2}{\beta + T_{cell}} \tag{3.2}$$

where $E_{gap(0)}$ is the band gap energy at 0 K, α and β are some constants, the values are given in Table 3.1.

Table 3.1 Parameters describing the band gab energy as function of temperature.

	Germanium	Silicon	Ga As	CIS	CdTe
Egap (0) [eV]	0.74	1.17	1.52	-	-
α [meV/K]	0.48	0.47	0.54	-	-
β [K]	235	636	204	-	-
Egap at 25 °C [ev]	0.67	1.11	1.40	1.01	1.44

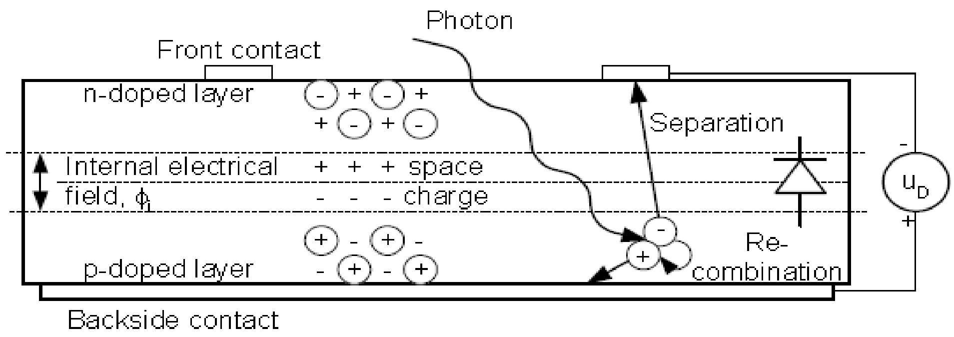
The energy of an incoming photon is:

$$E_{photon} = h.f = \frac{h.c}{\lambda} \quad (3.3)$$

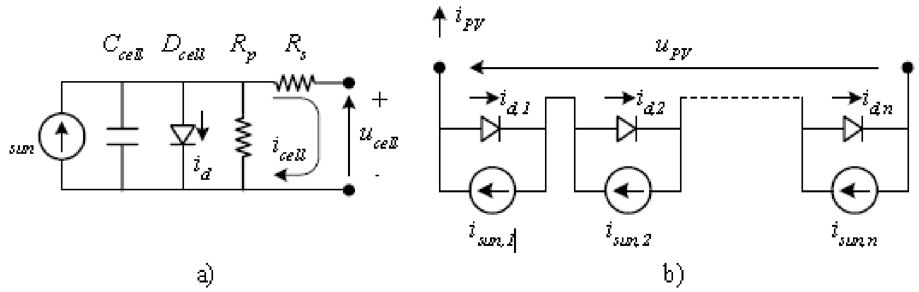
Where h is the Planck constant (h = 66.3×10^{-33} Js = 4.14×10^{-15} eV, 1 eV = 160×10^{-21}J), f is the frequency of the incoming photon, c is the speed of light (c = 300x106 m/s), and λ is the wavelength (79% of the suns spectrum is between 400 nm to 1500 nm). The energy-span for a ‘normal’ photon is therefore in the span from 0.84 eV to 3.15 eV.

4. FIGURES

4.1 FIGURES



4.2FIGURES



5. CONCLUSION

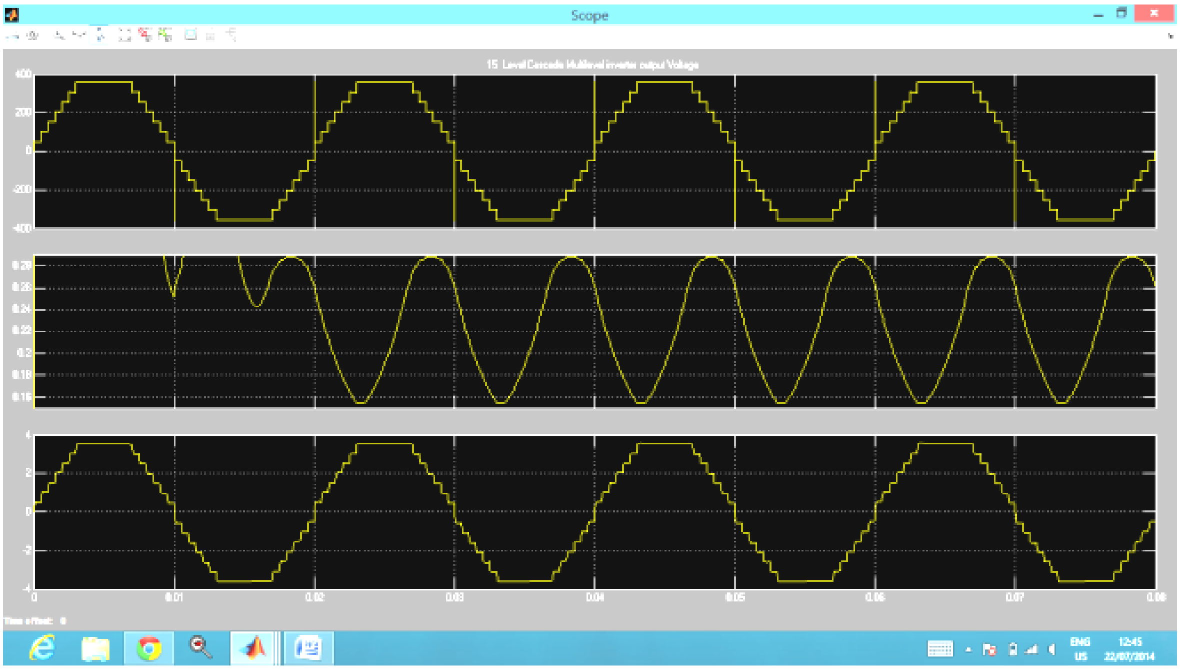
The model is drawn on MATLAB platform SIMULINK tool version MATLAB R2012A.after opening the Simulink simulation can be started by RUN button on the menu. Simulation completes in 30 seconds. Output of each given waveforms can be observed on the scopes which automatically opens or can be opened during run time or after simulation time is over. The projected design can be converting into a fully functional grid-tie inverter for establishing connection between the source and the grid for sending power to an electrical grid. The hardware of the projected grid-tie inverter could also be constructed with the help of a microcontroller and the experimental results can be compared with the ones obtained from the simulation. The simulation results would also be comprehensive in order to enlarge the horizon of the research.

The inverter should be tested for protection to irregular grid operation, e.g. voltage swells and sags, and phase jumps. Besides, the protection to notches and spikes should be investigated.

Analyze the impact on the grid performance (power quality) when multiple inverters are connected to a local grid. Especially, the effect from different waveform generators, for the current reference, and different current control strategies should be investigated. Both when the grid voltage is a pure sinusoidal and when it contains harmonics.

6. RESULT

Cascading of 7 half bridges form Multilevel Inverter to generate 15 level waveform of 380 V DC. This DC output is inverted into 15 level AC by the Full H bridge. The output of MLI of given level is observed in Figure 6.1 showing all the levels, max voltage and timings.



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