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Modeling and Simulation of DC to DC Converter With MPPT Control Scheme for Bio-Medical Applications

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***Abstract*— A DC-to-DC converter converts a source of direct current (DC) from one voltage level to another. It is a class of power converter. Most of the time this is a straight forward challenge for the electronic designer.Running wires or replacing batteries are impractical. So enter energy harvesting. Integrating energy-harvesting photodiodes with logic and exploiting on-die interconnect capacitance for energy storage will modify new, ultraminiaturized wireless systems. Unlike CMOS imager pixels, the planned photodiode styles utilize p-diffusion fingers and are enforced in an exceedingly standard logic method. Diffractive storage capacitors was designed in an exceedingly CMOS logic method. The diffractive effects is exploited to extend the photodiodes with switched-capacitor DC–DC converters were examined, with measurements indicating a five hundredth reduction within the output voltage ripple owing to the diffractive storage capacitance. Measurements show a rise in power generation for the newer CMOS technology, but at the value of reduced output voltage.A photodiode is a semiconductor device that converts light into current. A small current is also produced when no light is present. In our proposed work, we developed the Converter design which provides highly boosted output result.The complexity is also reduced than our previous work.**

***Intex Terms*— Complementary metal–oxide–semiconductor,DC-to-DC converter,MPPT,Bio-Medical Devices**

I. INTRODUCTION

CMOS is a technology for constructing integrated circuits. CMOS technology is used in microprocessors, microcontrollers, static RAM, and other digital logic circuits. CMOS technology is also used for several analog circuits such as image sensors (CMOS sensor), data converters, and highly integrated transceivers for many types of communication. CMOS is also sometimes referred to as complementary-symmetry metal–oxide–semiconductor (or COS-MOS). The words "complementary-symmetry" refer to the fact that the typical digital design style with CMOS uses complementary and symmetrical pairs of p-type and n-type metal oxide semiconductor field effect transistors (MOSFETs) for logic functions.Two important characteristics of CMOS devices are high noise immunity and low static power consumption. Since one transistor of the pair is always off, the series combination draws significant power only momentarily during switching between on and off states. Consequently, CMOS devices do not produce as much waste heat as other forms of logic, for example transistor–transistor logic (TTL) or NMOS logic, which normally have some standing current even when not changing state. CMOS also allows a high density of logic functions on a chip. It was primarily for this reason that CMOS became the most used technology to be implemented in VLSI chips.

The phrase "metal–oxide–semiconductor" is a reference to the physical structure of certain field-effect transistors, having a metal gate electrode placed on top of an oxide insulator, which in turn is on top of a semiconductor material. Aluminium was once used but now the material is polysilicon. Other metal gates have made a comeback with the advent of high-k dielectric materials in the CMOS process, as announced by IBM and Intel for the 45 nanometer node and beyond. "CMOS" refers to both a particular style of digital circuitry design and the family of processes used to implement that circuitry on integrated circuits (chips). CMOS circuitry dissipates less power than logic families with resistive loads. Since this advantage has increased and grown more important, CMOS processes and variants have come to dominate, thus the vast majority of modern integrated circuit manufacturing is on CMOS processes. CMOS circuits use a combination of p-type and n-type metal–oxide–semiconductor field-effect transistors (MOSFETs) to implement logic gates and other digital circuits. Although CMOS logic can be implemented with discrete devices for demonstrations, commercial CMOS products are

integrated circuits composed of up to billions of transistors of both types, on a rectangular piece of silicon of between 10 and 400 mm^2

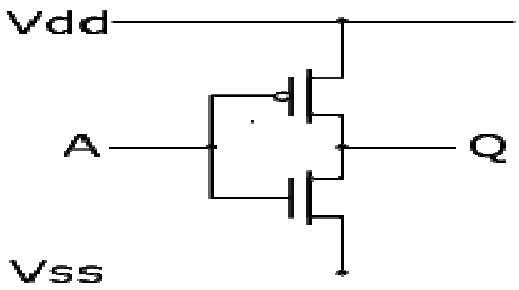

Fig. 1 Basic Block Diagram of CMOS Inverter

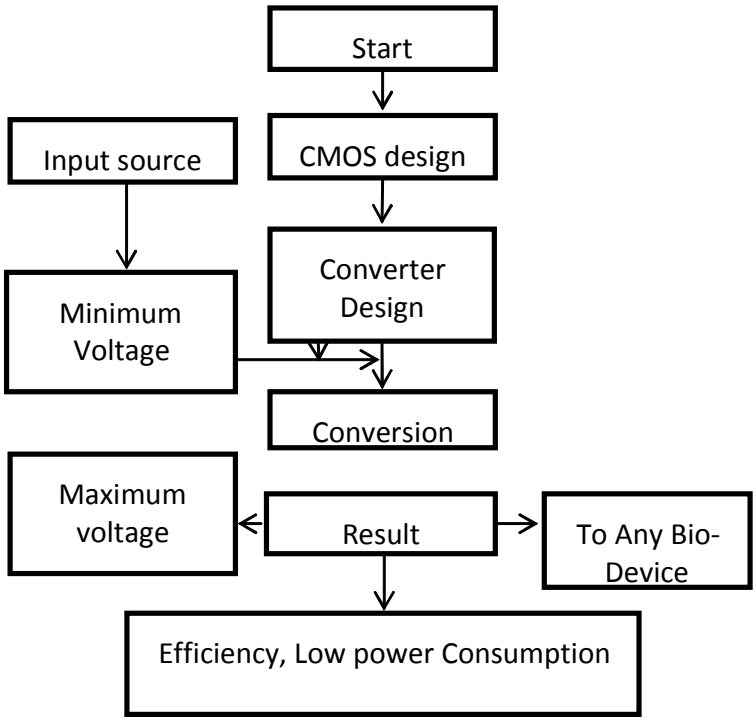

Fig.2 Design View of Proposed System

CMOS circuits are constructed in such a way that all PMOS transistors must have either an input from the voltage source or from another PMOS transistor. Similarly, all NMOS transistors must have either an input from ground or from another NMOS transistor. The composition of a PMOS transistor creates low resistance between its source and drain contacts when a low gate voltage is applied and high resistance when a high gate voltage is applied. On the other hand, the composition of an NMOS transistor creates high resistance between source and drain when a low gate voltage is applied and low resistance when a high gate voltage is applied. CMOS accomplishes current reduction by complementing every nMOSFET with a pMOSFET and connecting both gates and both drains together. A high voltage on the gates will cause the nMOSFET to conduct and the pMOSFET to not conduct while a low voltage on the gates causes the reverse. This arrangement greatly reduces power consumption and heat generation. However, during the switching time both MOSFETs conduct briefly as the gate voltage goes from one state to another. This induces a brief spike in power consumption and becomes a serious issue at high frequencies.

The image on the right shows what happens when an input is connected to both a PMOS transistor (top of diagram) and an NMOS transistor (bottom of diagram). When the voltage of input A is low, the NMOS transistor's channel is in a high resistance state. This limits the current that can flow from Q to ground. The PMOS transistor's channel is in a low resistance state and much more current can flow from the supply to the output. Because the resistance between the supply voltage and Q is low, the voltage drop between the supply voltage and Q due to a current drawn from Q is small. The output therefore registers a high voltage.On the other hand, when the voltage of input A is high, the PMOS transistor is in an OFF (high resistance) state so it would limit the current flowing from the positive supply to the output, while the NMOS transistor is in an ON (low resistance) state, allowing the output from drain to ground. Because the resistance between Q and ground is low, the voltage drop due to a current drawn into Q placing Q above ground is small. This low drop results in the output registering a low voltage.

In short, the outputs of the PMOS and NMOS transistors are complementary such that when the input is low, the output is high, and when the input is high, the output is low. Because of this behaviour of input and output, the CMOS circuits' output is the inverse of the input.The power supplies for CMOS are called V_{DD} and V_{SS}, or V_{CC} and Ground(GND) depending on the manufacturer. V_{DD} and V_{SS} are carryovers from conventional MOS circuits and stand for the drain and source supplies. These do not apply directly to CMOS since both supplies are really source supplies. V_{CC} and Ground are carryovers from TTL logic and that nomenclature has been retained with the introduction of the 54C/74C line of CMOS.

More complex logic functions such as those involving AND and OR gates require manipulating the paths between gates to represent the logic. When a path consists of two transistors in series, both transistors must have low resistance to the corresponding supply voltage, modelling an AND. When a path consists of two transistors in parallel, either one or both of the transistors must have low resistance to connect the supply voltage to the output, modelling an OR.Shown on the right is a circuit diagram of a NAND gate in CMOS logic. If both of the A and B inputs are high, then both the NMOS transistors (bottom half of the diagram) will conduct, neither of the PMOS transistors (top half) will conduct, and a conductive path will be established between the output and V_{ss} (ground), bringing the output low.

If both of the A and B inputs are low, then neither of the NMOS transistors will conduct, while both of the PMOS transistors will conduct, establishing a conductive path between the output and V_{dd} (voltage source), bringing the output high. If either of the A or B inputs is low, one of the NMOS transistors will not conduct, one of the PMOS transistors will, and a conductive path will be established between the output and V_{dd} (voltage source), bringing the output high. As the only configuration of the two inputs that results in a low output is when both are high, this circuit implements a NAND (NOT AND) logic gate.

An advantage of CMOS over NMOS is that both low-to-high and high-to-low output transitions are fast since the pull-up transistors have low resistance when switched on, unlike the load resistors in NMOS logic. In addition, the output signal swings the full voltage between the low and high rails. This strong, more nearly symmetric response also makes CMOS more resistant to noise.

II. DC TO DC CONVERTER

DC to DC converters are important in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.Most DC to DC converters also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage.

A. Linear

Linear regulators can only output at lower voltages from the input. They are very inefficient when the voltage drop is large and the current is high as they dissipate heat equal to the product of the output current and the voltage drop; consequently they are not normally used for large-drop high-current applications.The inefficiency wastes energy and requires higher-rated and consequently more expensive and larger components. The heat dissipated by high-power supplies is a problem in itself and it must be removed from the circuitry to prevent unacceptable temperature rises.

Linear regulators are practical if the current is low, the power dissipated being small, although it may still be a large fraction of the total power consumed. They are often used as part of a simple regulated power supply for higher currents: a transformer generates a voltage which, when rectified, is a little higher than that needed to bias the linear regulator. The linear regulator drops the excess voltage, reducing hum-generating ripple current and providing a constant output voltage independent of normal fluctuations of the unregulated input voltage from the transformer/bridge rectifier circuit and of the load current.

Linear regulators are inexpensive, reliable if good heat sinks are used and much simpler than switching regulators. As part of a power supply they may require a transformer, which is larger for a given power level than that required by a switch-mode power supply. Linear regulators can provide a very low-noise output voltage, and are very suitable for powering noise-sensitive low-power analog and radio frequency circuits. A popular design approach is to use an LDO, Low Drop-out Regulator, that provides a local "point of load" DC supply to a low power circuit.

B. Switched-mode conversion

Electronic switch-mode DC to DC converters convert one DC voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage. The storage may be in either magnetic field storage components (inductors, transformers) or electric field storage components (capacitors).

This conversion method is more power efficient (often 75% to 98%) than linear voltage regulation (which dissipates unwanted power as heat). This efficiency is beneficial to increasing the running time of battery operated devices.

The efficiency has increased since the late 1980s due to the use of power FETs, which are able to switch at high frequency more efficiently than power bipolar transistors, which incur more switching losses and require a more complicated drive circuit. Another important innovation in DC-DC converters is the use of synchronous rectification replacing the flywheel diode with a power FET with low "on resistance", thereby reducing switching losses.

Before the wide availability of power semiconductors, low power DC to DC converters of this family consisted of an electro-mechanical vibrator followed by a voltage step-up transformer and a vacuum tube or semiconductor rectifier or synchronous rectifier contacts on the vibrator.

Most AC-to-DC converters are designed to move power in only one direction, from the input to the output. However, all switching regulator topologies can be made bi-directional by replacing all diodes with independently controlled active rectification.

A bi-directional converter can move power in either direction, which is useful in applications requiring regenerative braking.Drawbacks of switching converters include complexity, electronic noise (EMI / RFI) and to some extent cost, although this has come down with advances in chip design.DC-to-DC converters are now available as integrated circuits needing minimal additional components. They are also available as a complete hybrid circuit component, ready for use within an electronic assembly.

C. Magnetic

In these DC-to-DC converters, energy is periodically stored into and released from a magnetic field in an inductor or a transformer, typically in the range from 300 kHz to 10 MHz. By adjusting the duty cycle of the charging voltage (that is, the ratio of on/off time), the amount of power transferred can be controlled. Usually, this is applied to control the output voltage, though it could be applied to control the input current, the output current, or maintain a constant power. Transformer-based converters may provide isolation between the input and the output. In general, the term "DC-to-DC converter" refers to one of these switching converters. These circuits are the heart of a switched-mode power supply.

D. Digital signal processor

A digital signal processor (DSP) is a specialized microprocessor (or a SIP block), with its architecture optimized for the operational needs of digital signal processing.The goal of DSPs is usually to measure, filter and/or compress continuous real-world analog signals. Most general-purpose microprocessors can also execute digital signal processing algorithms successfully, but dedicated DSPs usually have better power efficiency thus they are more suitable in portable devices such as mobile phones because of power consumption constraints. DSPs often use special memory architectures that are able to fetch multiple data and/or instructions at the same time.

III. MPPT (Maximum power point tracking)

Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices, typically solar panels. though optical power transmission systems can benefit from similar technology.

Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the I-V curve. It is the purpose of the MPPT system to sample the output of the cells and apply the proper resistance (load) to obtain maximum power for any given environmental conditions. MPPT devices are typically integrated into an electric power converter system that provides

voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors.

IV. EXPERIMENTAL RESULTS

The proposed design performs for Step-up process, this refers to produce the increased result than given input. The DC-DC circuit design converts the given source into process and for result it converts again the DC form as output. The Output is in Boosted form for Step-up process. This design modifies the circuit elements such as capacitance and resistance. And also the nodes used for connections are redesigned for reduced complexity.

A.Tanner

Tanner EDA provides of a complete line of software solutions for the design, layout and verification of analog and mixed-signal (A/MS) ICs and MEMS. Customers are creating breakthrough applications in areas such as power management, displays and imaging, automotive, consumer electronics, life sciences, and RF devices. A low learning curve, high interoperability, and a powerful user interface improve design team productivity and enable a low total cost of ownership (TCO). Capability and performance are matched by low support requirements and high support capability as well as an ecosystem of partners that bring advanced capabilities to A/MS designs. The company has shipped over 33,000 licenses of its software to more than 5,000 customers in 67 countries.

B. T-Spice: Analog Simulation

T-Spice is a complete design capture and simulation solution that provides accuracy and convergence with market-proven reliability. To transform your ideas into designs, you must be able to simulate large circuits quickly and with a high degree of accuracy. That means you need a simulation tool that offers fast run times, integrates with your other design tools, and is compatible with industry standards. To transform your ideas into designs, you must be able to simulate large circuits quickly and with a high degree of accuracy. That means you need a simulation tool that offers fast run times, integrates with your other design tools, and is compatible with industry standards.T-Spice offers HSPICE® and PSpice® compatible syntax and supports the latest industry models, including PSP, BSIM3.3, BSIM4.6, BSIM SOI 4.0, EKV 2.6, MOS 9, PSP, RPI a-Si & Poly-Si TFT, VBIC, and MEXTRAM models to allow easy integration of legacy designs and foundry models.T-Spice lets you precisely characterize circuit behavior using virtual data measurements, Monte Carlo analysis, and parameter sweeping.For greater efficiency and productivity, T-Spice puts you in control over your simulation process with an easy-to-use graphical interface and a faster, more intuitive design environment.With key features such as multi-threading support, automatic selection of advanced convergence algorithms, and command for easy what-if simulations with net list changes, T-Spice saves you time and money during the simulation phase of your design flow.Additional T-Spice Engine licenses can boost your innovation and experimentation capability with greater simulation capacity. Perform simultaneous runs and increase simulation run-time by adding up to ten (10) more engines.

C. S-Edit: Schematic Capture

Tightly integrated with Tanner EDA's T-Spice simulation, L-Edit layout editor, and HiPer verification tools, S-Edit gives you the power you need to handle your most complex full custom IC design capture. Its efficient design capture process integrates easily with third-party tools and legacy data. S-Edit enables you to explore design choices and provides an easy-to-use view into the consequences of those choices.

S-Edit's tight integration with SPICE simulation allows viewing operating point results directly on the schematic and performing waveform cross-probing to view node voltages and device terminal currents or charges.S-Edit imports schematics via Open Access and via EDIF from third party tools, including Cadence, Mentor, Laker, ORCAD and ViewDraw with automatic conversion of schematics and properties for seamless integration of legacy data.S-Edit's schematic design checks enables you to check your design for common errors such as undriven nets, unconnected pins and nets driven by multiple outputs so you can catch errors early before running simulations.

D. W-Edit: Waveform Viewing & Analysis

The W-Edit waveform analysis tool is a comprehensive viewer for displaying, comparing, and analyzing simulation results. W-Edit provides an intuitive multiple-window, multiple-chart interface for

easy viewing of waveforms and data in highly configurable formats.W-Edit is dynamically linked to T-Spice and S-Edit with a run-time update feature that displays simulation results as they are being generated and allows waveform cross-probing directly in the schematic editor for faster design cycles.Focus on and optimize your design with W-Edit's advanced features such as automatically calculating and displaying FFT results in a variety of formats, including dB or linear magnitude, wrapped or unwrapped phase, and real or imaginary parts.W-Edit allows creation of new traces based on mathematical expressions of other traces for advanced analysis and easy comparison with measured data.

V. CONCLUSION

In this paper,existing design of energy harvesting photodiode with Step-up process.In this proposed design of energy is convert from input to boosted output form. We are using DC-DC converter for this converting the circuit. An diffractive storage capacitance is proposed for the purpose of efficiency in the energy conversion.The form of the light is diffracted by a grating and depends on the structure of the elements,the number of elements is present.The design is based on CMOS design methodology.Fully focused on reduction of power and reduced the circuit delay.The overall parameters are achieved the better performance of the existing designs.This design is held on CMOS design methodology and we have used Tanner EDA version 13.0 as simulation tool to show the performance analysis.

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