

# International Journal of Innovative Research in Science, Engineering and Technology

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## MOSFET Based High Efficient Solar Inverter

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**ABSTRACT:** The solar inverter is made up of thousands of components that's why it is very complex. Nearly 80% of losses come from a switching device and AC inductors. One of the most critical components within PV inverter is this "switching device" or semiconductor device being used to perform DC to AC conversion. Historically, the solar industry has relied on MOSFET for this device. The MOSFET is the heart of the PV inverter where power conversion really takes place. Efficient conversion of DC power to AC requires the inverter to store energy from the panel while the grid's AC voltage is near zero, and then release it again when it rises. This requires considerable amounts of energy storage in a small package. The MOSFET is the heart of the PV inverter where power conversion really takes place. We have design the high efficient MOSFET based solar converter. We design this converter with the help of MOSFET and diodes. This implementation is done by using MATLAB Simulink. By changing the internal parameters we improve the efficiency of the system i.e. 98.18%.

**KEYWORDS:** PV inverter, MOSFET, Efficiency, Simulink.

### I. INTRODUCTION

The energy issue is a global concern, given the recurrent crises in the electricity sector. Over the past decade, the energy sectors of many countries endured intense changes with stimulus to the de-centralization of power generation, giving the distribution networks central role in this new model. Energy generation plays a key role in human life, along with means of transportation, telecommunications, water and sanitation.

A **solar micro-inverter**, or simply **micro inverter**, is a device used in photovoltaic that converts direct current (DC) generated by a single solar module to alternating current (AC). The output from several micro inverters is combined and often fed to the electrical grid. Micro inverters contrast with conventional string and central solar inverters, which are connected to multiple solar modules or panels of the PV system.

micro inverters have several advantages over conventional inverters. The main advantage is that small amounts of shading, debris or snow lines on any one solar module, or even a complete module failure, do not disproportionately reduce the output of the entire array. Each micro inverter harvests optimum power by performing maximum power point tracking (MPPT) for its connected module.[1] Simplicity in system design, lower amperage wires, simplified stock management, and added safety are other factors introduced with the micro inverter solution.

The primary disadvantages of a micro inverter include a higher initial equipment cost per peak watt than the equivalent power of a central inverter since each inverter needs to be installed adjacent to a panel (usually on a roof). This also makes them harder to maintain and more costly to remove and replace (O&M). Some manufacturers have addressed these issues with panels with built-in micro inverters.[2]

Efficient conversion of DC power to AC requires the inverter to store energy from the panel while the grid's AC voltage is near zero, and then release it again when it rises. This requires considerable amounts of energy storage in a small package. The lowest-cost option for the required amount of storage is the electrolytic capacitor, but these have relatively short lifetimes normally measured in years, and those lifetimes are shorter when operated hot, like on a rooftop solar panel. This has led to considerable development effort on the part of micro inverter developers, who have introduced a variety of conversion topologies with lowered storage requirements, some using the much less capable but far longer lived film capacitors where possible.

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## II. WHY EFFICIENCY IS SO IMPORTANT TO SOLAR

Power conversion efficiency has certainly been a very popular topic in solar industry. PV inverter manufacturers have invested significant amount of effort to achieve even a 0.1% higher efficiency year over year. But just how important is efficiency to a solar system?

The U.S. installed more than 7 GW of solar in 2014. Every single installation required some type of power conversion from DC (solar panel) to AC (grid). To simplify the discussion, if we assume 97% efficiency for the inverter loss, that equals about 6.86 GW of AC power generated. If all the inverters performed at 98% power conversion efficiency, and all else being equal, that number would be 6.93 GW. That is a 70-MW difference and equivalent to a large utility-scale PV plant! Higher efficiency equates to more energy harvest and is therefore critically attributed to the total revenue stream of the PV system.

The PV inverter is a complex piece of equipment made up of thousands of components. Roughly 80% of losses come from a switching device and AC inductors. One of the most critical components within PV inverter is this “switching device” or semiconductor device being used to perform DC to AC conversion. Historically, the solar industry has relied on MOSFET for this device. The MOSFET is the heart of the PV inverter where power conversion really takes place.

## III. MOSFET BASED SOLAR CONVERTER

The circuitry is divided into three main parts:

- Circuitry part
- Reading part
- Monitor Part

MOSFET based solar converter working is divided in three sub parts. Each part is interconnected with each other and shows the outputs.

### Circuitry part

Main Circuitry part consist of three solar panels with 500 cells each. Solar input is shown by irradiance of 1500w/m<sup>2</sup>.

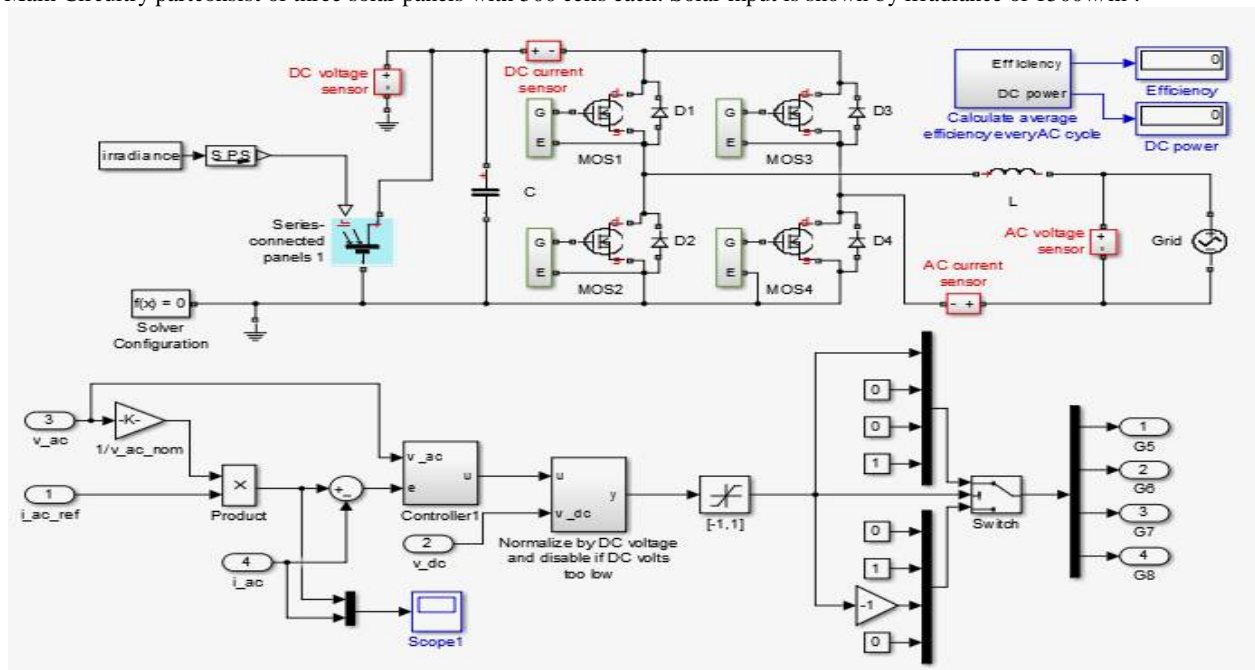


Fig 1: MOSFET based solar converter main circuit

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Cell signal is converted into physical signal using SPS (Simulink physical converter). This physical signal is connected with the one input of the panels and second input is connected with the MOSFET's (MOS1 and MOS2) drain's. The 3<sup>rd</sup> pin of the panel is attached with the function solver. This function solver provides the solver settings for simulation like consistency tolerance, Delay memory budget, and Linear Algebra and Filtering time constant. We can change these settings according to requirements. Four diodes are used in this circuit and each diode is connected between the drain and source of the each MOSFET's respectively. Here we apply the 4 kinds of meters i.e. DC voltage meter for measuring the v\_dc (stored DC voltage), DC current meter for measuring the (stored i\_dc current), AC voltage meter for measuring the v\_ac (out AC voltage), and AC current meter for measuring the (out i\_ac current) respectively. The ideal AC voltage source help to maintain the sinusoidal voltage across its output terminals, independent of the current flowing through the source. The output voltage is defined by

$$V = V_0 * \sin(2*\pi*f*t + PHI)$$

Where V<sub>0</sub> is the peak amplitude, f is the frequency in Hz, and PHI is the stage shift in radians.

### Reading Part

This part of circuit is used for measuring the results based on the inputs given to main circuit and designing of the circuit. For calculating the results for meters are designed i.e DC voltage sensor, DC current sensor, AC voltage sensor and AC current sensor.

#### DC Voltage sensor

DC voltage sensor is designed for calculating the converted DC voltage from solar energy. Below fig shows the design of DC voltage sensor.

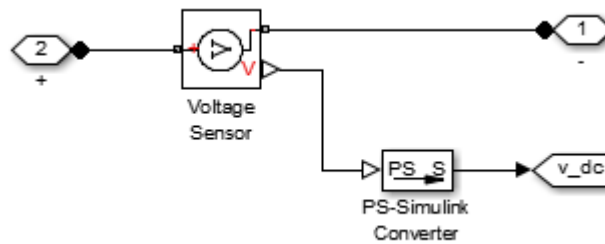


Fig 2 DC voltage sensor

Terminal 2 of solar panel is connected with the voltage sensor then output of voltage sensor is converted into V<sub>dc</sub> by using Simulink physical converter and terminal 1 is grounded.

#### DC current sensor

DC current sensor is designed for calculating the converted DC current from solar energy. Below fig shows the design of DC current sensor.

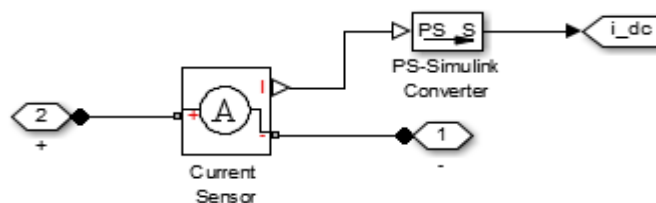


Fig 3 DC current sensor

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Terminal 2 of solar panel is connected with the current sensor then output of current sensor is converted into  $I_{dc}$  by using Simulink physical converter and terminal 1 is grounded.

### AC Voltage sensor

AC voltage sensor is designed for calculating the converted AC voltage from solar energy. Below fig shows the design of AC voltage sensor.

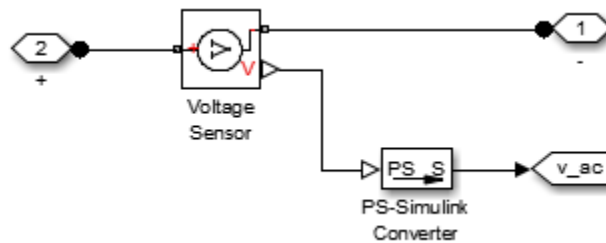


Fig 4 AC voltage sensor

Terminal 2 of solar panel is connected with the current sensor then output of current sensor is converted into  $V_{ac}$  by using Simulink physical converter and terminal 1 is grounded.

### AC current sensor

AC current sensor is designed for calculating the converted AC current from solar energy. Below fig shows the design of AC current sensor.

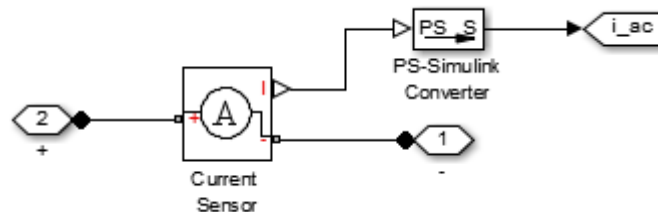


Fig 5 AC current sensor

Terminal 2 of solar panel is connected with the current sensor then output of current sensor is converted into  $I_{ac}$  by using Simulink physical converter and terminal 1 is grounded.

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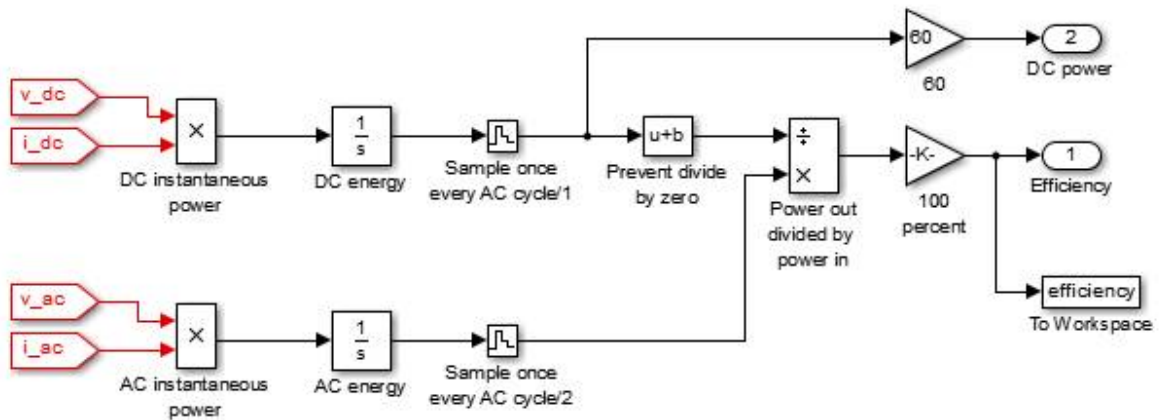


Fig 6: Efficiency and DC power measuring circuit

The above circuit has four inputs connected with the AC and DC instantaneous power. DC instantaneous power has two DC inputs i.e.  $v_{dc}$  (DC voltage),  $i_{dc}$  (DC current) and AC instantaneous power also has two inputs i.e.  $v_{ac}$  (AC voltage) and AC current. The above circuitry is used for measuring the stored DC power and efficiency of the output (ac converted w.r.t dc stored).

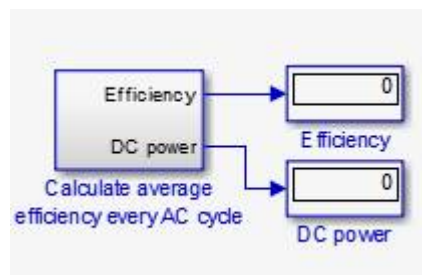


Fig 7: Efficiency and DC power meter

The figure 7 shows the efficiency and DC power meter. This meter shows the results on their respective blocks.

## Monitor Part

The 3<sup>rd</sup> part shows the waveform of the outputs results. This generator has three inputs that are coming from the main circuit one input is taken as reference input and this reference input is constant. There inputs are  $i_{ac\_ref}$  (reference input),  $v_{dc}$  (DC voltage measure by DC voltage meter),  $v_{ac}$  (AC voltage measure by AC voltage meter) and  $i_{ac}$  (AC current measure by AC current meter). Waveform is generate by these four inputs. These inputs are further goes

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to the controller for controlling action accordingly and these controlled inputs are given to the gate inputs of the MOSFET's.

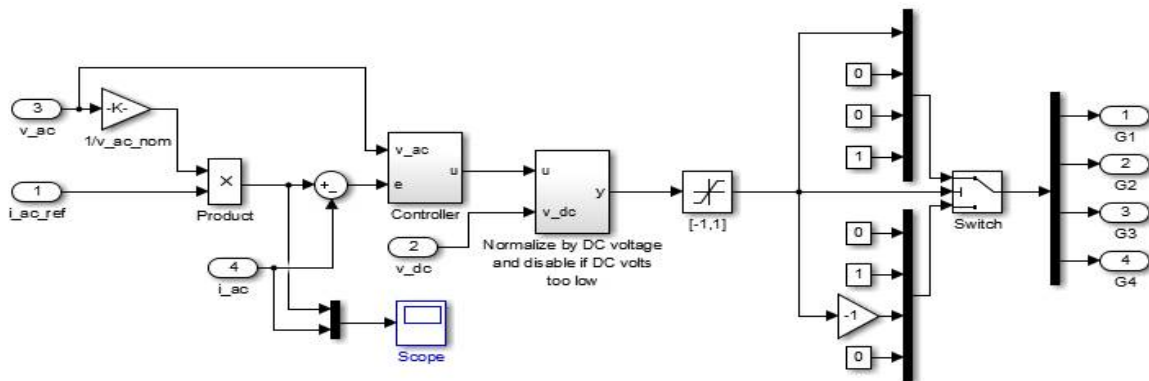


Fig 8: Waveform generator

The above fig shows the wave form of the output result i.e. AC gain with respect to DC stored. This wave form generate on the basis of the efficiency of the device more the efficiency more the gain result i.e AC voltage and current

## IV. EXPERIMENTAL RESULTS

The output of the MOSFET solar inverter shown in the fig 9.

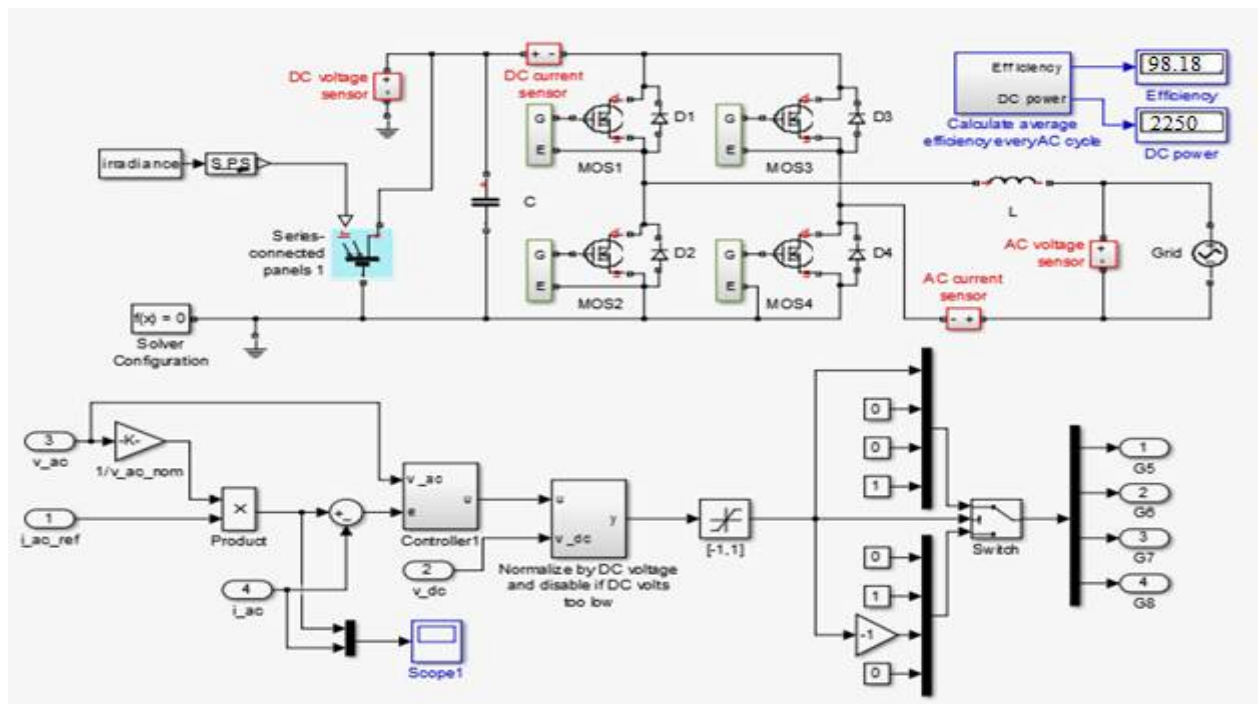


Fig 9: MOSFET based solar converter after simulation

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For the better results we work on the MOSFET's that are shown in the above fig. We change the MOSFET's configuration for the better results. Here we work on the current and voltage of the MOSFET's. We parameterization the MOSFET as specify from the datasheet.

The above fig shows the main configuration of MOSFET and this setting will be same for all the MOSFET's. These values are given below in the table 1.

Table 1: Parameter values for MOSFET's

Parameter	Value
Drain-Source on resistance (R_DS)	0.1 ohm
Drain current (Ids)	25 A
Gate-Source voltage (Vgs)	4.8 V
Gate-Source threshold voltage (Vth)	1.7 V

After these setting we simulate the circuit and we get the output in form of efficiency and DC power stored.

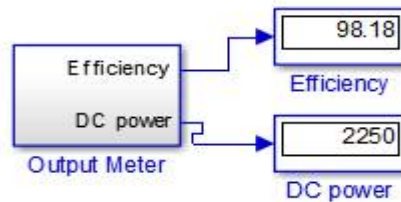


Fig 7: Output results

The above fig shows the output of the circuit. The DC power i.e stored is 2250 v and get 98.18 % AC power of DC power.

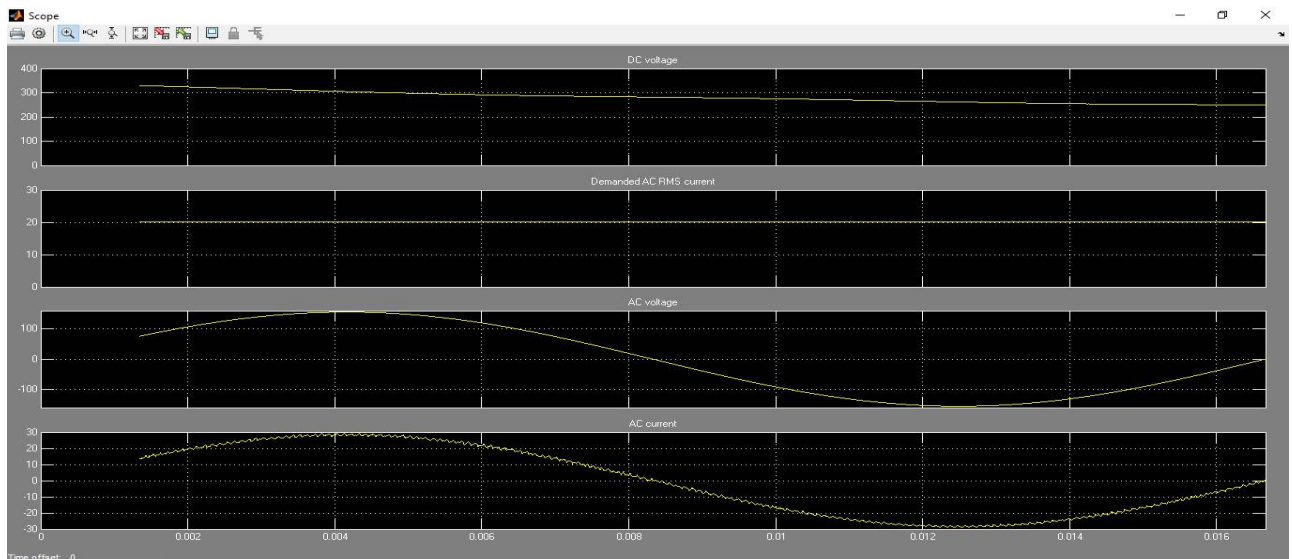


Fig 8: wave form of the output

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The above waveform shows the output of the solar converter. It shows the four output waveforms. First shows the DC voltage that is get from the DC voltage meter, second wave form shows the demanded AC rms current i.e.  $i_{ac\_ref}$  taken as constant, third wave shows the AC voltage and fourth wave shows the AC current this is get from the stored DC voltage and current.

## V. CONCLUSION

The solar inverter is a complex piece of equipment made up of thousands of components. Roughly 80% of losses come from a switching device and AC inductors. One of the most critical components within PV inverter is this “switching device” or semiconductor device being used to perform DC to AC conversion. Historically, the solar industry has relied on MOSFET for this device. The MOSFET is the heart of the PV inverter where power conversion really takes place. We have design the high efficient MOSFET based solar converter. We design this converter with the help of MOSFET and diodes. This implementation is done by using MATLAB Simulink. By changing the internal parameters we improve the efficiency of the system i.e. 98.18%.

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