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Designing Control in a Grid 22kv Connecting Photo-Voltaic System

Dương Quynh Nga[1], Nguyen Trong Toan[2]
[1]Department of Electrical Engineering, Thai Nguyen University of Technology, Vietnam
[2]Faculty of Electronics, Thai Nguyen University of Technology, Vietnam

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ABSTRACT: The studied grid connecting photo-voltaic system is very important. It crucially contributed to exploit the natural energy when traditional energy is dwindling.
The paper gives a solution electrical control system uses solar power national grid.
KEYWORDS: The Photo-Voltaic system, Grid connected Photo-Voltaic system, Connected Grid.

SYMBOL:
PV: Photo-Voltaic
U_{PV}, I_{PV}: voltage and current of the solar panel
U_G, I_G: three-phase current of the Grid.
C_{DC}: DC link capacitance
R_f, L_f : resistance, inductance of the grid.
SVM : Spatial Vector Modulation Method
DC – DC: DC - DC converter (Voltage booster or Boost Converter)
DC – AC: DC – AC converter (Inverter)
ABBREVIATIONS:
MPPT: Maximum Power Point Tracking
PWM: Pulse - Width – Modulation
VSI: Voltage Source Inverter

I. INTRODUCTION

Solar energy is one of the most important renewable energy sources that nature has given our planet. At the same time, it is also the source of other renewable energy sources such as wind energy, biomass energy, river energy, etc. Solar energy can be said to be inexhaustible. However, in order to exploit and use this energy source, it is necessary to know its basic characteristics and properties, especially when reaching the earth's surface.

Vietnam is a developing country, so the demand for energy is increasing. Currently, Vietnam's national policy on energy demand is based on the establishment of a system of hydroelectric power plants, steam and gas turbine thermal power plants, a number of nuclear power plants... However, to To ensure sustainable development and especially balance the country's energy in the future, Vietnam has been focusing on research and development of new energy sources in which solar energy is still a dark energy source. future advantages for Vietnam's conditions in terms of geography and economic development needs. Recent changes show that the application and exploitation of solar energy has made new strides.

To exploit and use solar energy efficiently, a smart grid system is required. When there is sunlight, it will generate direct current (DC) energy, this DC energy is converted into alternating current (AC) by the inverter. The controller is responsible for transmitting this energy to the grid.

II. THEORY OF GRID-CONNECTED SOLAR POWER SYSTEM

In practice we have encountered many stand-alone solar power systems. This technology is often applied to off-grid industrial areas or for special consumption, small capacity loads. The disadvantage is that you have to use a battery pack, which is both expensive, requires regular care and pollutes the environment. On the other hand, the battery pack can only store a limited amount of power, but with tens or hundreds of kW solar arrays, using a battery is a huge problem, even impossible. .

For large-scale applications people use grid-tied solar technology. In this technology, the electricity from the generator, which is a solar panel, is converted into an alternating current of suitable voltage and frequency by the power converters (Inverter) and fed into the industrial power grid. When using electricity, people get electricity from the grid. The power grid acts as a "bank", storing electricity when the solar array generates electricity and providing it back to consumers when needed. Thanks to this power bank, the use is always stable and very energy efficient.
Figure 1 presents an overview of the grid-connected solar power system.

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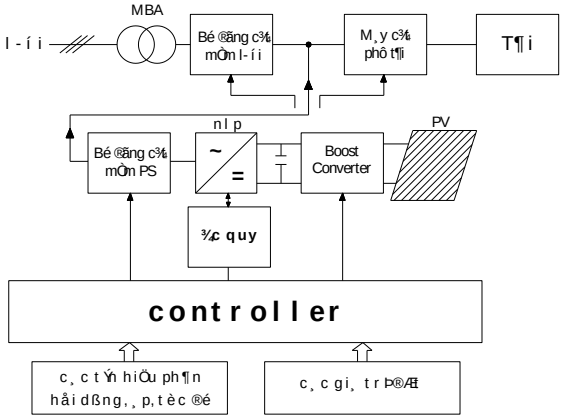

Figure 1: Grid-connected solar power system

Below is the schematic diagram of the whole system control:

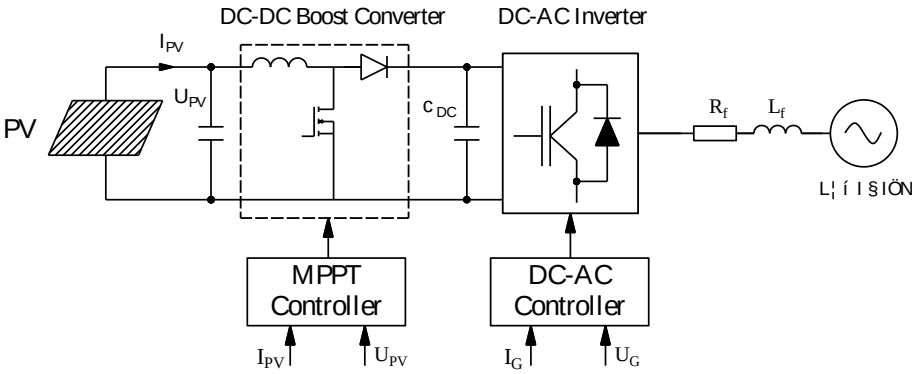

Figure 2: System control principle diagram

In which: MPPT Controller is the controller of the maximum power from the solar panel. This set works to control the energy from the solar panel to always MAX in all unstable conditions of weather, climate, light and dark time, radiation intensity... Output signal of MPPT controller directly control the valve opening and closing of the DC - DC unit.

III. GRID-CONNECTED SOLAR POWER SYSTEM CONTROL SOLUTION

The article proposes a solution to control the grid-connected power system. The control algorithm from part and the whole system is simulated on Matlab Simulink software.

a. Solar Panels:

Choose a Solar Panel:

- Module Type: SunPower SPR – 305 – WHT
- Quantity: 330 modules
- The Solar Panel consists of 66 batteries placed in parallel with each other, each battery array has 5 modules in series. The capacity of the battery pack is: 66.5.305,2 = 100,7 kW.

Battery specs:

- Open circuit voltage: Uoc=64.2 V; Current Isc=5.96 A
- Current and voltage at the point of maximum battery capacity is:

Ump = 54.7 V; Imp = 5.58 A.

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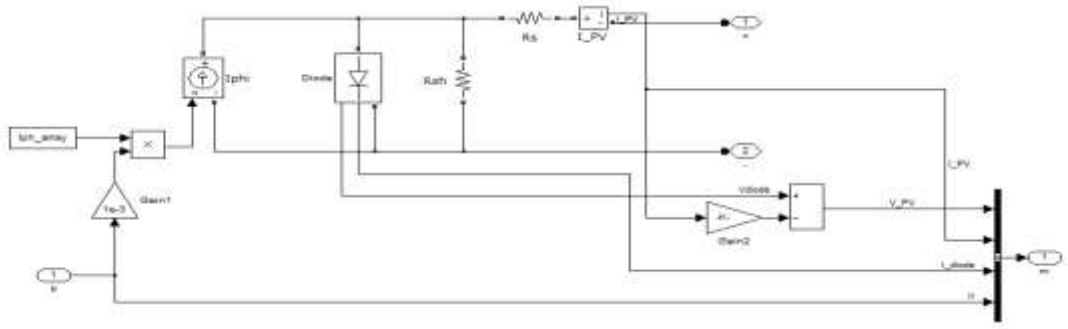

Figure 3: Simulation diagram for control of Solar panel

b. The Controller of Boost Converter

The controller for Boost Converter takes the input signal as voltage from the UPV solar array, outputs the UDC signal to feed it to the DC/AC inverter input.

The Boost Converter performs the task of converting DC voltage from 273.5V to 500V. In this voltage conversion process, there is the intervention of the controller to get the maximum power point of the MPPT battery.

Conduct simulation on Matlab Simulink software with parameters: C_3 = 100 µF, C_1 = C_2 = 12000 µF; L_1 = 5 mH, R_1 = 0.005 will give the result as shown in figure 5

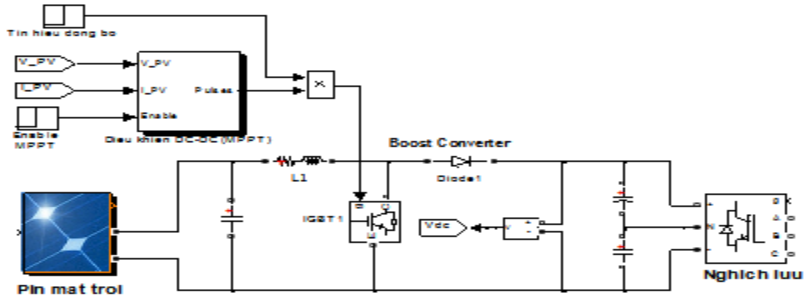

Figure 4: Simulation diagram of Boost Converter

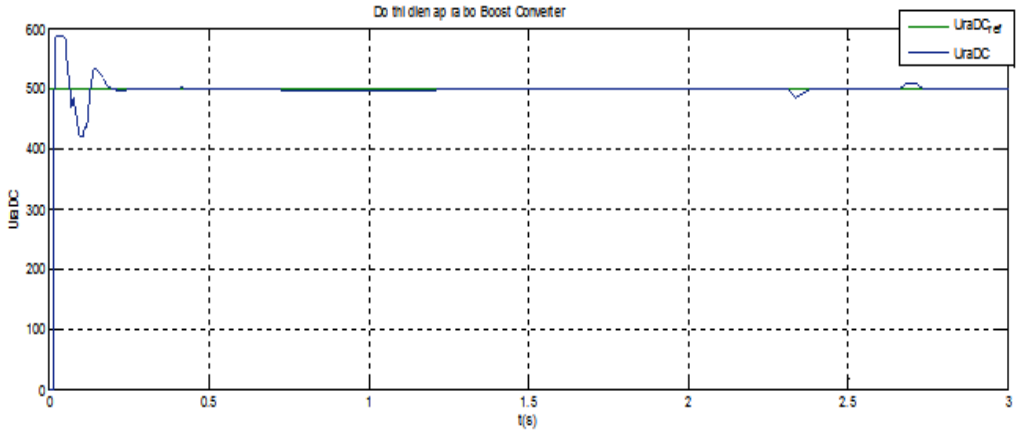

Figure 5: Output voltage graph of DC-DC unit

c. Control circuit for three-phase DC/AC voltage inverter (Voltage Source Inverter - VSI)

To control the DC/AC inverter, there are two main control methods: current control and voltage control. But current control has advantages and is more suitable for grid-connected control than voltage control, so the author chooses the control method for the inverter as current control.

The control circuit of the inverter will generate a signal to control the operation of the IGBTs, the inverter control signal is designed in the style of pulse width modulation (PWM). However, to reduce harmonics and improve output voltage

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quality, people use spatial vector modulation (SVM).

The inverter control system uses two control loops. The first is an external control loop to stabilize the voltage of the DC link circuit at a voltage of 250V. The second is an internal control loop to control the feedback current from the grid I_d and I_q.

The Idref current is the output of the external DC voltage controller. To maintain the power factor the system takes the reference $I_{qref} = 0$.

The voltages U_d and U_q are obtained at the output of the current controller. These two voltages are calculated to give a reasonable U_{ref_abc} set voltage signal to the control pulse generator using SVM modulation at the DC/AC inverter.

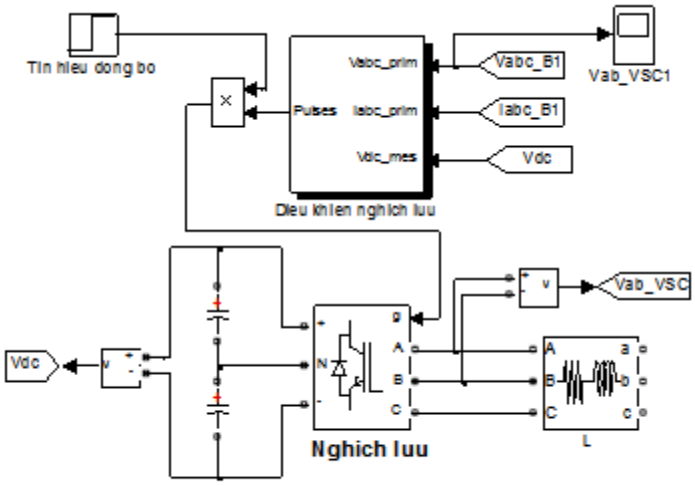

Figure 6: Simulation diagram of DC/AC . Controller

d. PLL (Phase-locked-loop) circuit:

PLL (Phase-locked-loop) is a feedback system consisting of a phase detector, low-pass filter (LPF: Low-pass filter), amplifier and voltage controlled oscillator circuit (VCO: Voltage-controlled oscillator) in some PLL circuits, the VCO can be replaced by a CCO (Current-controlled oscillator).

In essence, PLL works on the control loop principle that the input and output quantities are frequencies and they are compared with each other in phase. The phase control loop is responsible for detecting and correcting the frequency errors between the input and output signals, that is, the PLL is for the output frequency f_O of the comparator to follow the input frequency f_i of the signal. enter.

When there is no input signal Vi, the amplifier output voltage $V_{out} = 0$, the VCO oscillator operates at the natural frequency f_N (set by the external resistor and capacitor).

Digital phase detection by EXOR port.

The use of phase-switched EXOR gate has two advantages: high full-range gain compared to other gates and output pulse twice the frequency regardless of input frequency.

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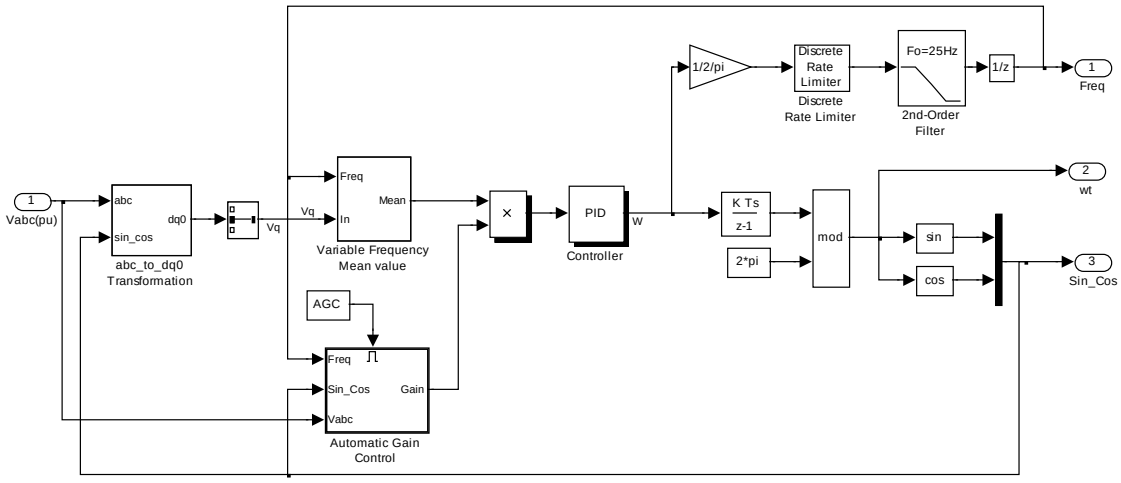

Figure 7: Diagram depicting the PLL phase-locked loop circuit

The control circuit of the whole system is shown in Figure 8.

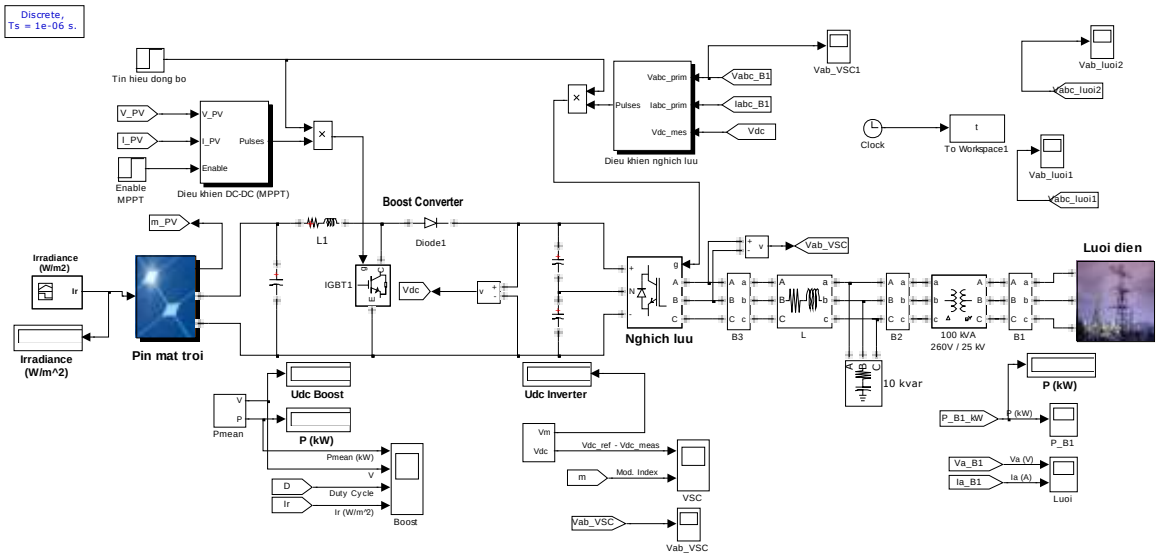

Figure 8: Control circuit of the whole system

Simulation results

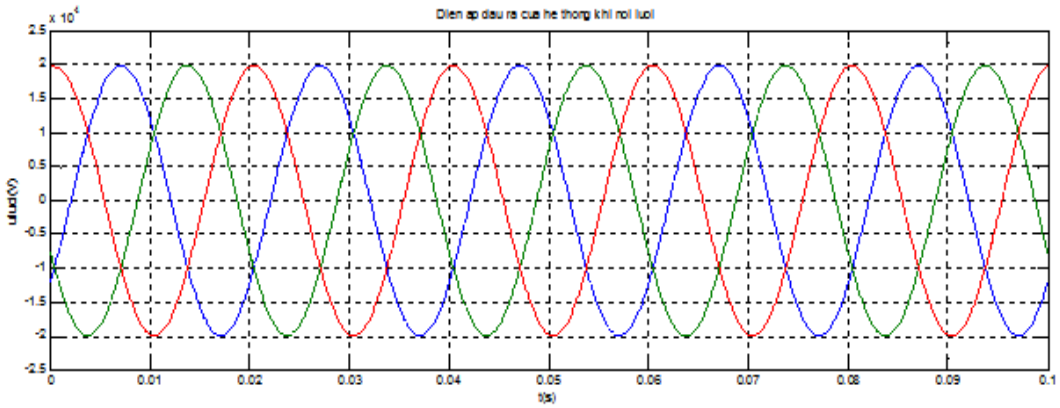

Figure 9: System output voltage when connected to the grid

IV. CONCLUSION

- The article presented some overview of solar energy sources and grid-connected solar power system.
- The article also proposes a solution to control the grid-connected solar power system.
- Conducted simulation on Matlab - Simulink software and gave simulation results.

The simulation results show honestly, confirming the correctness of the control algorithm construction.

- It is necessary to research to find a way to overcome the model error so that the research results between the mathematical model and the actual model are not much different so that the research results with the mathematical model can be applied directly for real models.

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