CHAPTER FOUR
STATCOM Simulation

4.1 Introduction

The National grid is analyzed using load flow program in order to determine the weakest point in the grid. The analysis shows that there are many buses need to be reinforced to bring their voltage to the nominal value. Also there are some line are overloaded and need to be compensated to increase their loading capacity. Recently all networks are moved toward FACT device for both voltage compensation and line increasing capacity. The STATCOM is connected in shunt with buses to regulate the reactive power in order to recover the voltage to 1.0 pu. Also the TCSC used in series in line to increase line capacity.

In consequence with carried load flow analysis, the NEC final report about national grid critical and weaknesses areas in the system were Giad, Mrainjan, Bageer, KiloX, Khartoum East,Faroog, Mnagel and Hag abdallah substations.

The suggested solutions from NEC to enhance and reinforce the system include: expansion of existing substation, building new substations, adding bigger capacity transformers and installation of FACTs devices such as STATCOM and TCSC.

In this research, a STATCOM is connected in Marnijan substation as one of the weakest point in national grid to increase the voltage from 0.73pu to 1.0pu and improve system stability. The national grid at Marnijan simplified to synchronous machine, transformer, transmission line, loads and STATCOM.

4.2 Test System

Figure (4.1) shows the simplified test system which represents the Marnijan substation. 150MW is connected to Sinnar Bus and supplied through 110KV π transmission line connecting Sinnar and Marnijan substations. 250MVA synchronous machine used to supply Marnijan 13.8kV/110kV transformer rated at 250MVA. STATCOM based on voltage source converter is connected in Marnijan Bus to control the voltage. The STATCOM is controlled using carrier-based sinusoidal PWM plus with 2 kHz switching frequency. The STATCOM performance is examined under several network loads. Table (4.1) summarises the test system parameters.

Table (4.1) Parameters of the test system used in simulation

STATCOM rating	250MVA	k_{pdc}	0.0015
DC link voltage	28.7 kV	k_{idc}	1.2
DC link capacitance	2000000000μF	k_{pi}	3
Interfacing transformer impedance in per unit	0.008+j0.1	k_{ii}	300
Switching frequency	2.1kHz	k_{pv}	0.0015
Modulation strategy	SPWM plus triplen harmonic injection	k_{iv}	200

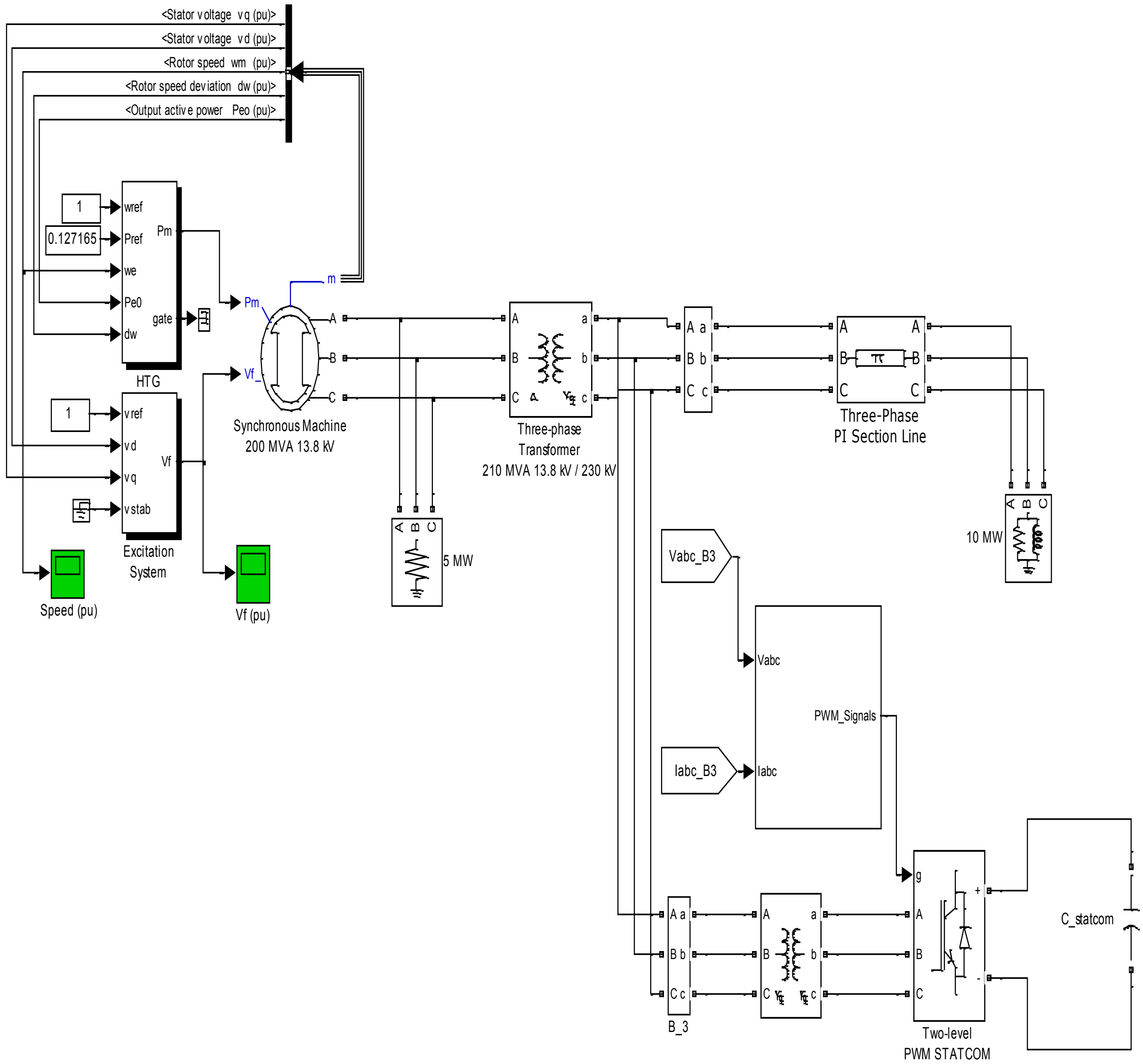

Figure (4.1) Test system

4.3 Simulation:

The performance of the STATCOM on Figure (4.1) is investigated during several cases. The STATCOM is examined during full load capacity of the line (150MW) and light loads of 10MW and 100MW respectively. The converter dc link voltage is regulated at 28.3kV and controlled using dc and ac voltage controllers in order to maintain dc link voltage and ac bus voltage.

The simulation result when the system is operated to supply 150MW+j56MVAr is shown in Fig.4.2 to Fig.4.4. Fig.4.2 demonstrates the ability of STATCOM to provide voltage support to critical loads in Marnijan Bus. It is clear from the Figure (4.2) that the voltage is maintained at 1.0 pu. As shown from Fig.4.3 the STTACOM is regulate the reactive power at connection point to 90MVAr to keep the voltage at rated voltage. Finally Fig. 4.4 shows the active and reactive power at Marnijan bus bar.

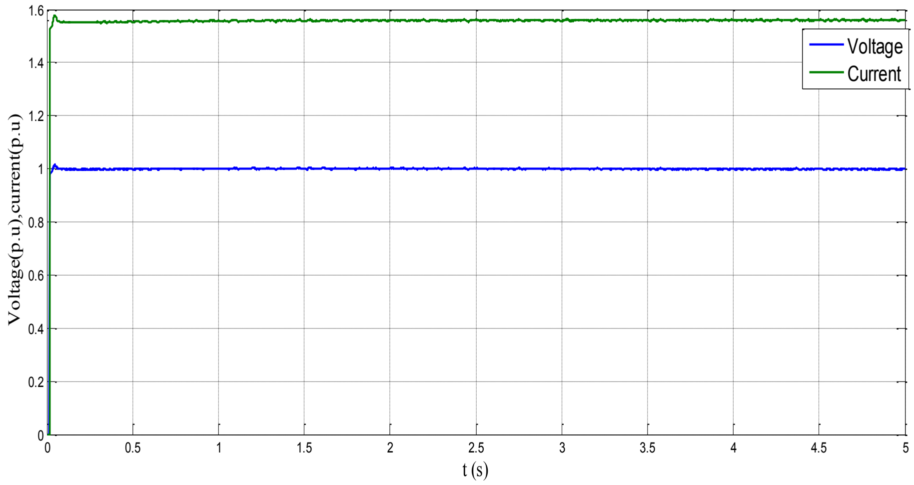

Figure (4.2) Voltage and Current at Marnijan bus

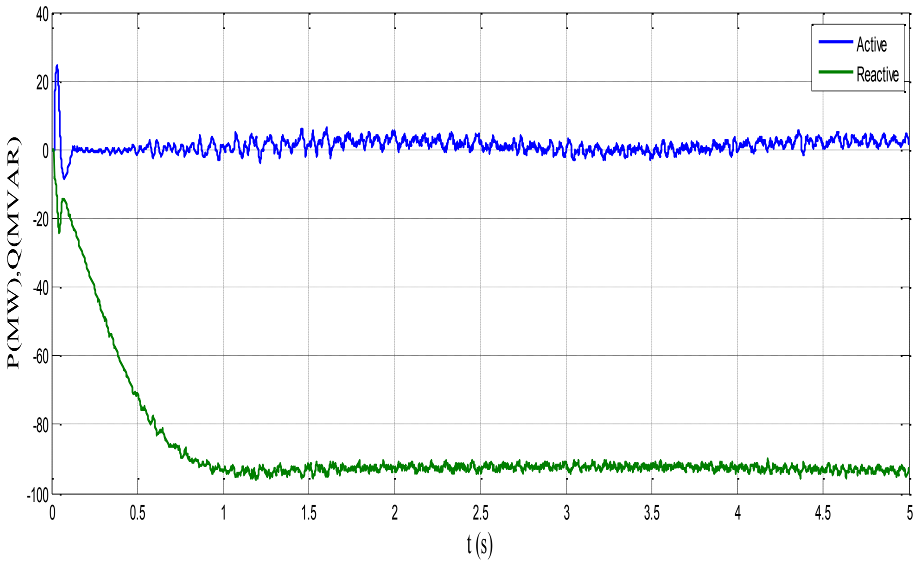

Figure (4.3) Active and reactive power of STATCOM

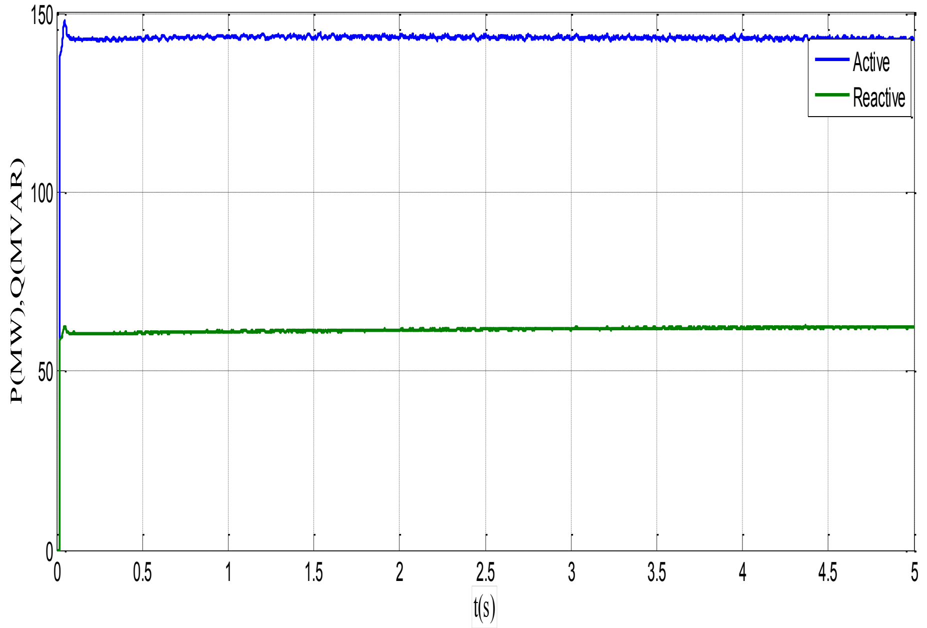

Figure (4.4) Active and reactive power at Marnijan bus

The simulation result when the system is operated to supply 10MW+j4.3MVAr is shown in Fig.4.5 to Fig.4.7. Fig.4.5 demonstrates the ability of STATCOM to maintain the voltage at 1.0 pu. As shown from Fig.4.6 the STTACOM is regulates the reactive power at connection point to 25MVAr to keep the voltage at rated voltage. Finally Fig. 4.7 shows the active and reactive power at Marnijan bus bar.

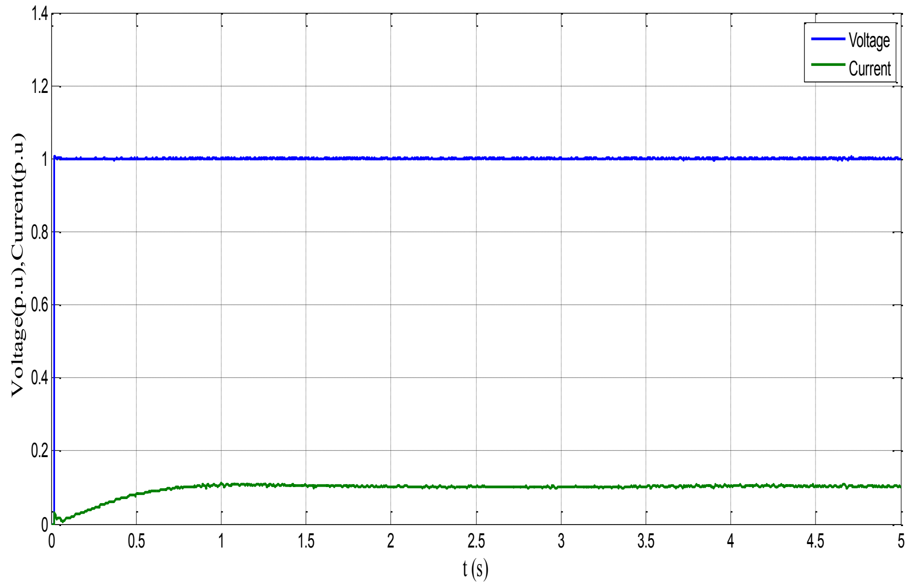

Figure (4.5) Voltage and Current at Marnijan bus

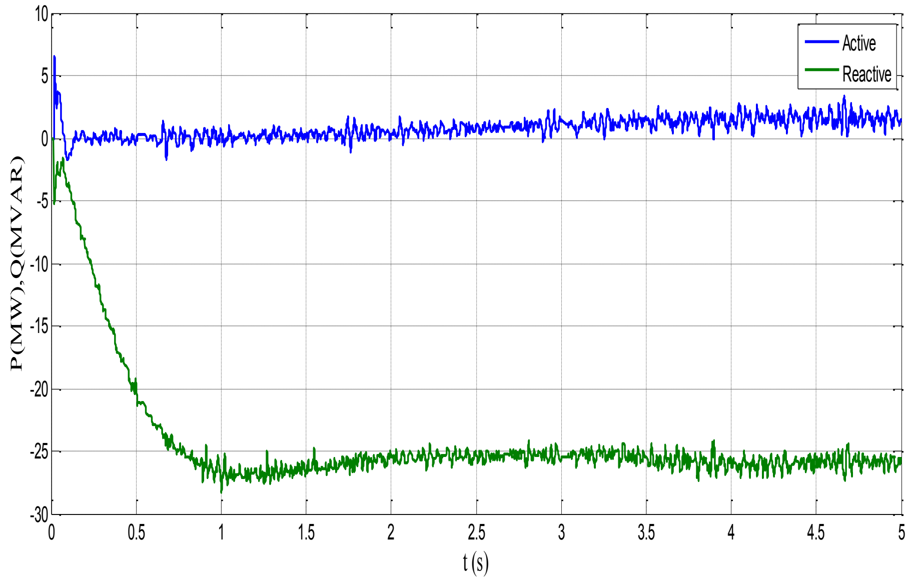

Figure (4.6) Active and reactive power of STATCOM

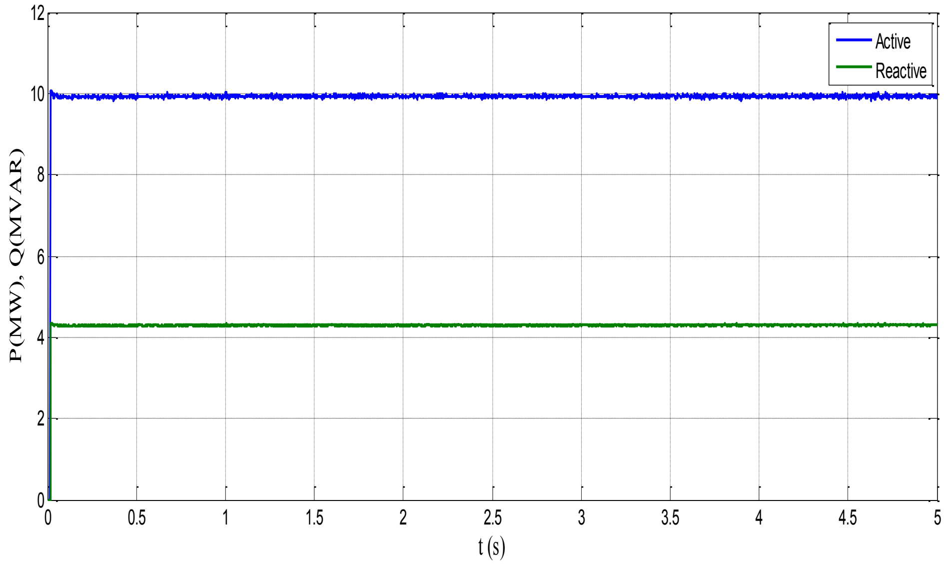

Figure (4.7) Active and reactive power at Marnijan bus

The simulation result when the system is operated to supply 100MW+j36MVAr is shown in Fig.4.8 to Fig.4.10. Fig.4.8 demonstrates the ability of STATCOM to provide voltage support to critical loads in Marnijan Bus. It is clear from the figure that the voltage is maintained at 1.0 pu. As shown from Fig.4.9 the STTACOM is regulate the reactive power at connection point to 50MVAr to keep the voltage at rated voltage. Finally Fig. 4.10 shows the active and reactive power at Marnijan bus bar.

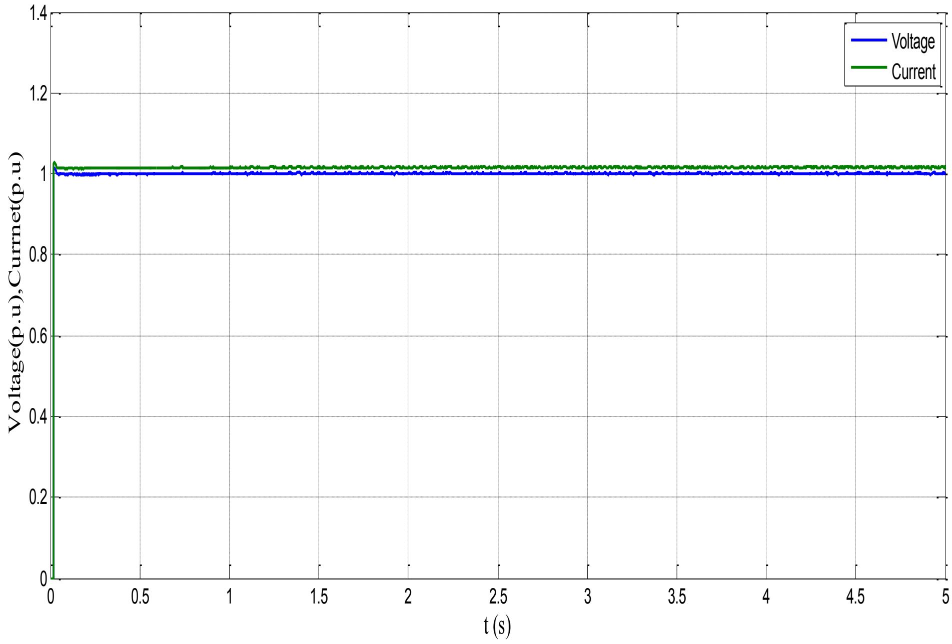

Figure (4.8) Voltage and Current at Marnijan bus

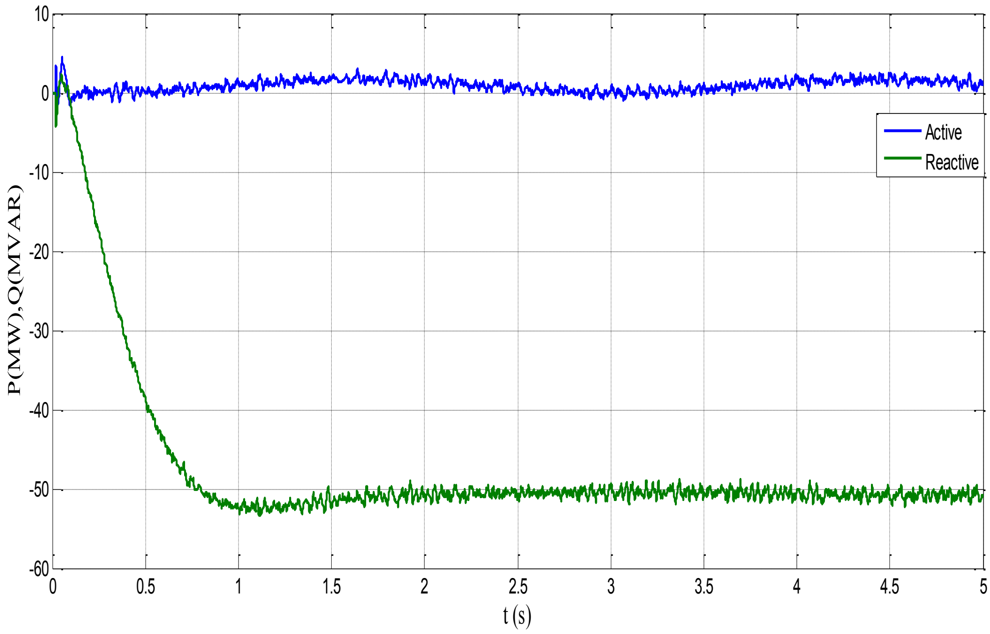

Figure (4.9) Active and reactive power of STATCOM

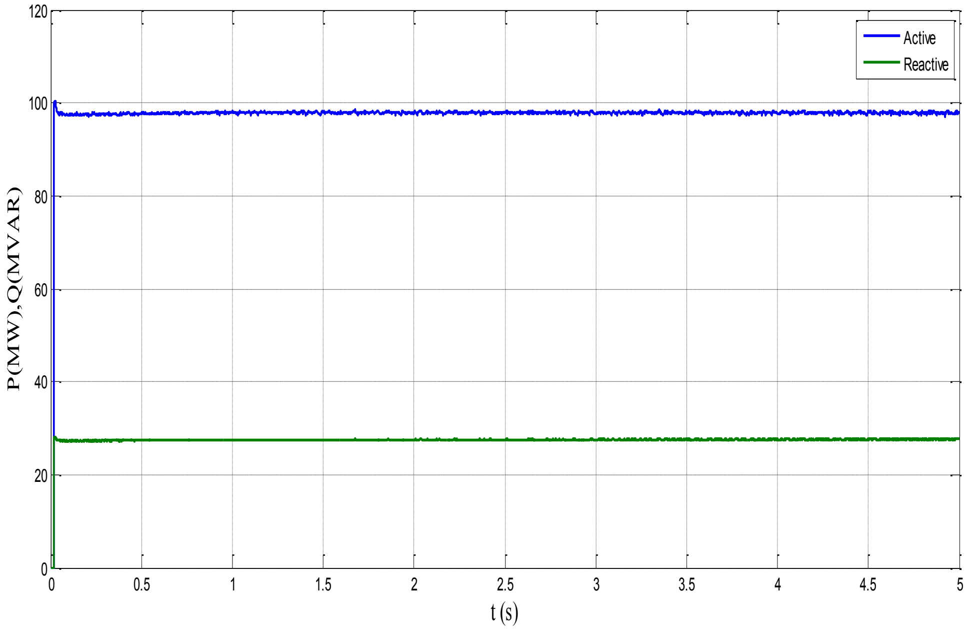

Figure (4.10) Active and reactive power at Marnijan bus