The PSCAD/EMTDC Modelling of JeJu AC Power System

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Abstract—In this paper, the PSCAD/EMTDC modeling of JeJu AC power system with wind farms will be discussed. And the modelling of the synchronous generator, exciter, governor will also be defined in the JeJu power system by using the PSCAD/EMTDC. At the same time the fault analysis and the power flow analysis in JeJu AC power system are presented to demonstrate the JeJu AC power system can perfectly simulate the real JeJu power system function. Through the simulation using PSCAD/EMTDC we have gained the same results compared with the results accomplished by the PSS/E, so the validity of the modelling for the JeJu power system by using PSCAD/EMTDC is confirmed.

Index Terms— PSCAD/EMTDC (Power System Computer Aided Design/Electro Magnetic Transients including DC System), PSS/E(Power System Simulator for Engineering), AC Power System, Fault Analysis, Power Flow Analysis

1.Introduction

In recent years, there has been growing interest in renewable energy systems due to the environmental problem and the economic benefits from fossil fuel savings. Wind Power Generation System (WPGS) is one of the most useful energy resources using natural environment. The WPGS production is undoubtedly accompanied with minimization of environmental pollution, reduction of losses in power system transmission and distribution equipments, and supports the utility in demand side management [1]. At the same time, a large-scale, nonlinear, nonstationary, multivariable wind power systems are becoming more complex to operate and to control, so the controller undoubtedly should be designed using the power system software(PSCAD) as well as we can. Usually, The standard power system controllers, such as the generator exciter and automatic voltage regulator (AVR), speed governor , power system stabilizer (PSS) and power electronics-based flexible ac transmission system (FACTS) devices[2], are not all existed in the PSCAD software so the development and modelling should be achieved by ourselves. So, this paper mainly presents the modelling of the wide-area JEJU AC power system, and the modelling of the important AC transmission system devices such as gererator, excitor, governor, based on PSCAD/EMTDC software, for a power system with power system stabilizers, a large wind farm and multiple flexible ac transmission system (FACTS) devices.

2. JEJU AC Power system modelling

AC power system diagram of the Jeju-Haenam AC power system is shown in Fig.1. This modelling including the East-jeju, South-jeju, Hanlim and where there is abundance of wind energy to build large wind farms was interconnected as a big system and simulated by using PSCAD/EMTDC in this figure.

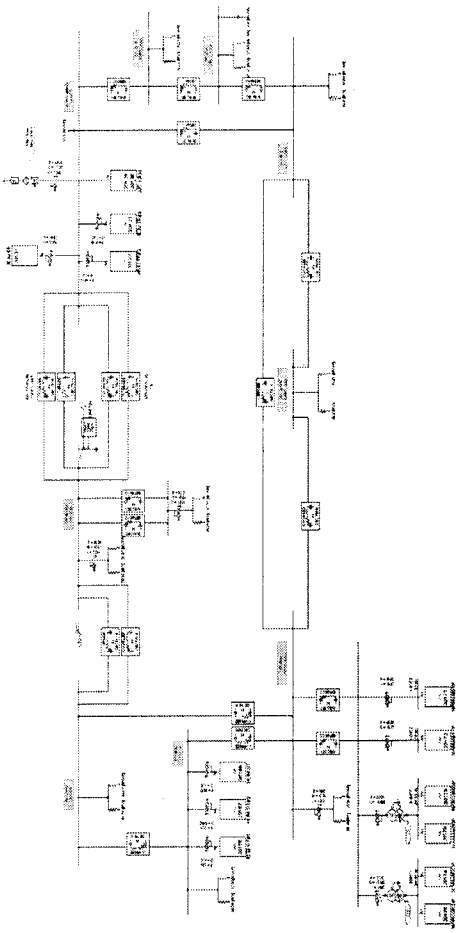


Fig.1 AC power system PSCAD-modelling diagram of the Jeju-Haenam

Table 1 PSCAD-controller modelling compared with PSS/E(1)

Bus Number	Bus Name	Generator Modelling	Exciter Modelling	Exciter Modelling (PSCAD)	Governor Modelling	Governor Modelling (PSCAD)
20122	JEJU TP#2	GENROU	EXAC2	EXAC2A	IEEEG1	GOV1+TUR1
20123	JEJU TP#3	GENROU	EXAC2	EXAC2A	IEEEG1	GOV1+TUR1
20125	JEJU GT#1	GENROU	IEEEX2	AC5A	No Necessary	No Necessary
20126	JEJU GT#2	GENROU	IEEEX2	AC5A	No Necessary	No Necessary
20131	JEJU DP#1	GENSAL	EXPIC1	ST4B	DEGOV	DEGOV
20166	Hanlim GT#1	GENROU	EXPIC1	ST4B	GAST2A	GAST2A
20167	Hanlim GT#2	GENROU	EXPIC1	ST4B	GAST2A	GAST2A
20168	Hanlim ST#1	GENROU	EXPIC1	ST4B	GAST2A	GAST2A
20172	South-Jeju TP#3	GENROU	EXST1	EXST1	IEEEG1	GOV1+TUR1
20173	South-Jeju TP#4	GENROU	EXST1	EXST1	IEEEG1	GOV1+TUR1
20176	South-Jeju DP#1	GENSAL	SCRX	SCRX	TGOV1	TGOV1
20176	South-Jeju DP#2	GENSAL	SCRX	SCRX	TGOV1	TGOV1
20178	South-Jeju DP#3	GENSAL	SCRX	SCRX	TGOV1	TGOV1
20178	South-Jeju DP#4	GENSAL	SCRX	SCRX	TGOV1	TGOV1
120	HVDC	CDC4T	CPAAUT			

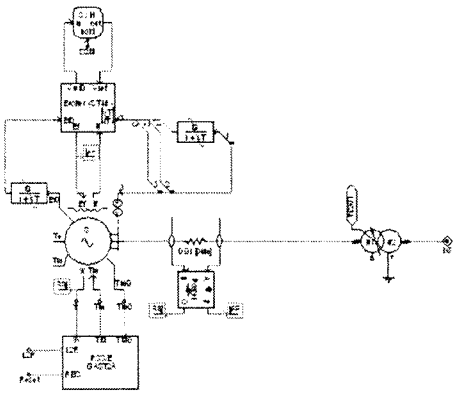
Table 2 PSCAD-controller modelling compared with PSS/E(2)

Bus Number	Bus Name	Remark
20122	JEJU TP#2	EXAC2A : PSCAD UDM defined modelling, IEEEG1:GOV4+TUR1(same modelling)
20123	JEJU TP#3	EXAC2A : PSCAD UDM defined modelling, IEEEG1:GOV4+TUR2(same modelling)
20125	JEJU GT#1	same modelling as AC5A except TC,TB=0 in IEEEX2
20126	JEJU GT#2	same modelling as AC6A except TC,TB=0 in IEEEX2
20131	JEJU DP#1	same modelling as ST4B except KF=TA2=TA3=TA4=KE=TE=0, DEGOV : PSCAD UDM defined modelling
20166	Hanlim GT#1	same modelling as ST4B except KF=TA2=TA3=TA4=KE=TE=0, GAST2A : PSCAD UDM defined modelling
20167	Hanlim GT#2	same modelling as ST4B except KF=TA2=TA3=TA4=KE=TE=0, GAST2A : PSCAD UDM defined modelling
20168	Hanlim ST#1	same modelling as ST4B except KF=TA2=TA3=TA4=KE=TE=0, GAST2A : PSCAD UDM defined modelling
20172	South-Jeju TP#3	EXST1 : PSCAD UDM defined modelling, IEEEG1:GOV4+TUR1(same modelling)
20173	South-Jeju TP#4	EXST1 : PSCAD UDM defined modelling, IEEEG1:GOV4+TUR1(same modelling)
20176	South-Jeju DP#1	SCRX,TGOV1 : PSCAD UDM defined modelling
20176	South-Jeju DP#2	SCRX,TGOV1 : PSCAD UDM defined modelling
20178	South-Jeju DP#3	SCRX,TGOV1 : PSCAD UDM defined modelling
20178	South-Jeju DP#4	SCRX,TGOV1 : PSCAD UDM defined modelling
120	HVDC	the equivalence source modelling

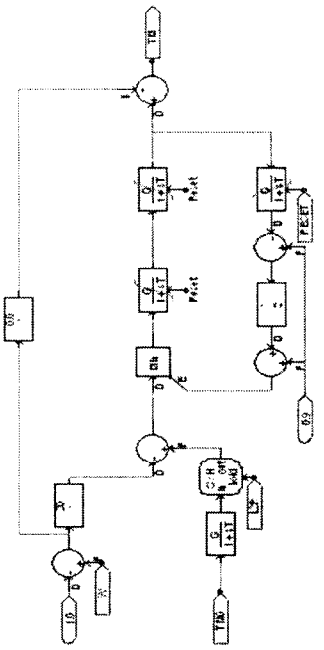
3. The controller(generator, exciter, governor) modelling compared with PSS/E

Table 1 shows the type of the controller including generator, exciter and governor in the PSCAD master library referring to the PSS/E and the differences between PSCAD modelling and PSS/E modelling were exactly presented in table 2.

Take Hanlim GT#1(20166) as an example, the circuit of the generator, exciter and governor system is presented in the Fig.2(a). Especially, the governor which we have developed refers to the GAST2A in PSS/E, as shown in Fig.2(b).



(a) Generator modelling

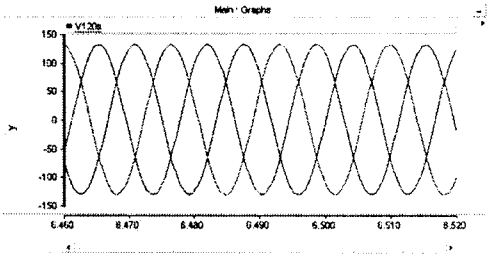


(b) Governor modelling

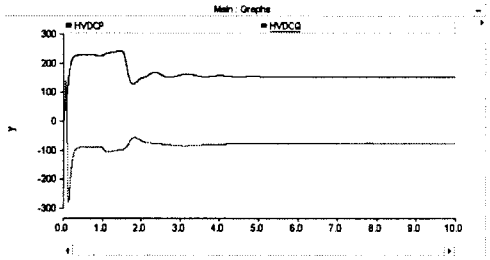
Fig.2 Hanlim GT#1(20166) modelling

4. The simulation results

Instantaneous voltage of 120 bus is shown in Fig.3(a). And HVDCP is instead for real power(pu), HVDCQ is instead for reactive power(pu), as shown in Fig.3(b). Fig.4 shows the 120 BUS-3 phase ground fault with the duration 0.1sec. And Table 3 shows PSCAD-Simulation result compared with PSS/E, from the voltage we can ealily know that the PSCAD modelling can perfectly simulate the real JeJu power system function than PSS/E.



(a)120 Bus 3-phase



(b)Real power and reactive power

Fig.3 PSCAD-simulation result

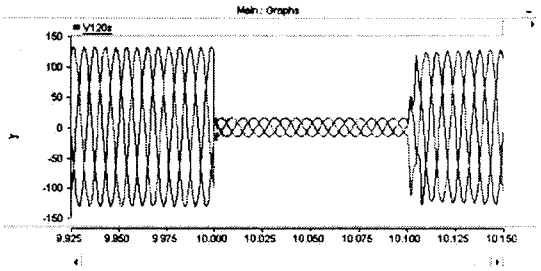


Fig.4 120 Bus fault

Bus Number	Bus Name	Voltage(pu)		Error(pu)
		PSCAD	PSS/E	
120	JEJU TP	1.0330	1.0375	0.0450
130	East-Jeju	1.0210	1.0360	0.0150
140	Shin-Jeju	1.0210	1.0298	0.0088
150	Hanlim	1.0240	1.0316	0.0076
160	Andeok	1.0180	1.0404	0.0224
180	Sinseo	1.0090	1.0326	0.0236
190	Halla	1.0110	1.0334	0.0224
200	Seangsung	1.0070	1.0317	0.0247
210	Sunge	1.0070	1.0353	0.0283
220	Jocheon	1.0070	1.0375	0.0305

Table 3 PSCAD-Simulation result compared with PSS/E

5. Conclusion

This paper mainly presents the modelling of the wide-area JEJU AC power system, and the modelling of the important AC transmission system devices such as generator, excitor, governor, based on PSCAD/EMTDC software. Through the fault analysis and the power flow analysis in JeJu AC power system demonstrated that the JeJu AC power system can perfectly simulate the real JeJu power system function. Also we have gained the same results compared with the results accomplished by the PSS/E and conquered the problems in PSS/E such as the PSS modelling parameter abnormity and so on, so the validity of the modelling for the JeJu power system by using PSCAD/EMTDC is confirmed.

References

[1]S.G. Han, I.K. Yu, M. Park(2007) PSCAD/EMTDC-based simulation of wind power generation system

[2]Wei Qiao, Ganesh K. Venayagamoorthy, Ronald G. Harley(2008) Optimal wide-area monitoring and nonlinear adaptive coordinating neurocontrol of a power system with wind power integration and multiple FACTS devices