PSCAD Model Test Checklist

Revision 4

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Purpose

This document is a test checklist meant to accompany the PSCAD Model Requirements document[1] and the PSCAD Model Requirements Supplier Checklist[2]. The procedures provided in this document are intended to provide an indication of the core model accuracy, performance, and usability features specified in the model requirements. These procedures cannot ultimately prove that the model is compliant with all requirements, as black box models usually hide the details of the equipment controls and protection. It is recommended that the equipment manufacturer supply additional confirmation that the model meets each individual requirement. The requirements in this document do not necessarily represent interconnection criteria for specific individual systems, and may be supplemented or adjusted based on interconnection region.

The tests outlined here are considered "basic", and may be supplemented by more rigorous testing, including various fault types, depths, and durations, as well as more extensive protection testing and benchmarking against phasor models. This document is not intended to be a guide for thorough benchmarking between PSCAD, PSS/E, and actual equipment, and is subject to revision as the state of the art in EMT modeling evolves.

Model test Summary	
Model Test date:	
Project Name:	
Manufacturer:	
Equipment type: (eg. PV or Wind)	
Equipment version:	
Documentation file:	
Model Files supplied:	

[1] Recommended PSCAD model requirements Rev. 8, Electranix, February 24, 2020
[2] PSCAD Model Requirements Supplier Checklist R2, Electranix, 2020

Verification Procedure and Checklist

		Pass/Fail	Comments
Vendor and site specific model verification			
1a	The Vendor's name and the specific version of the model should be clearly observable in the .psc model file.		
1b	Documentation and supporting model filenames should not conflict with model version shown in the .psc model file.		
1c	Model is supplied with a test circuit which is configured for the site specific application.[3]		
"Real Code" model verification			
2a	Controls are black-boxed, and no PSCAD master library control blocks are visible within control circuits.[4] If the model is not based on "real code", a separate validation report is required showing model comparison against hardware tests.[5]		
Model usability verification			
3a	Model uses a timestep greater than 10 µs[6]		
3b	Model allows a variation in simulation timestep		
3c	Model compiles using Intel FORTRAN version 12		
3d	Model initializes in 5 seconds or less with a POI level SCR of 2.5. Real power, reactive power, and RMS voltage should reach steady state by this time.		
3e	Model allows multiple instances of itself to be run together in the same case[7]		
Model electrical configuration verification			
4a	Plant level electrical single line diagram (SLD) is included.		
4b	Generator step-up transformer(s) included, with impedance between 5 and 10% on generator base, and matches SLD.[8]		

[3] The test circuit should model all relevant electrical components of the plant and contain a system equivalent. Parameters will be assumed to be site-specific, unless there are obvious indications otherwise, such as an incorrect grid base frequency.
[4] Black-boxing of controls to a high level does not guarantee that real-code is embedded into the model, however the visibility of PSCAD master-library control blocks in the inner control loops (PLL, inner current controllers, etc.) suggest that the model is generic in nature. Model documentation may contain information on use of real-code in the model.
[5] All aspects of the controller operation are required to be validated by utilizing a "hardware in loop" platform or other hardware test systems. Model should not be validated against other software models. Validations should include control responses to various types of faults, changes in power and voltage references, changes in system frequency, testing frequency response in sub and super-synchronous ranges, and testing of protection operation. Tests should also be performed under a variety of system strengths, including very weak systems. Other tests may also be required. The validation report is required along with any model updates that result from the more rigorous validation tests.
[6] Models with timesteps less than 10 µs may be acceptable in situations where a small timestep does not significantly increase the runtime of the total simulation
[7] Depending on specific application and whether E-Tran Plus for PSCAD is allowed to be used to overcome the limitation, this requirement may be waived.
[8] Impedance range is for sanity checking only. Impedances outside this range may be allowed.

4c	Lumped collector equivalent(s) included, with total charging equal to between 0.5 and 5% of plant rating, and matches SLD.[8]		
4d	Substation transformer(s) included, rated appropriately for plant size, and impedance between 6 and 12% on transformer base, and matches SLD.[8]		
4e	Model can be scaled to represent any number inverters/turbines, either using a scaling transformer or internal scaling.		
4f	All external devices included in the plant (such as STATCOMs) include appropriate models.		
Plant controller verification			
5a	Model includes power plant controller (PPC)		
5b	PPC accepts an external active power setpoint.		
5c	PPC accepts a voltage setpoint.		
5d	PPC has a mechanism to implement a settable voltage droop.		
5e	Overall plant responds to frequency changes by increasing or decreasing its active power as appropriate. This may be accomplished either at an inverter level or via the PPC.[9]		
5f	Model initializes to the setpoints specified in the PPC. If droops or deadbands are utilized, the initial values may differ from the setpoints.[10]		
5g	If external voltage control devices (STATCOM/DVAR, SVC, MSCs) are included int the plant, ensure that the voltage control of these devices is coordinated with the PPC, with no potential for VAR looping or oscillations.		
Basic performance verification[11]			
6a	Instantaneous voltage and current waveforms have minimal distortion, and no oscillations are observed.		
6b	Model is able to ride-through and recover from a temporary (no line outage or drop in SCR), 6-cycle, zero-impedance, three-phase fault at the high side of the station transformer, with a POI level SCR of 2.5.		
6c	Model responds to a step change in PPC voltage setpoint, reaching 90% of the new value between 1 and 10 seconds in a test system with		

[9] Non-compliance with this item may not require model revision as frequency response may not be required in PSCAD models by some utilities. In this case, a description of the under/over frequency response capabilities of the actual equipment should be provided by the manufacturer.

[10] If voltage control with droop is implemented, it is preferred that the PPC model requests an initial Q value to match the voltage setpoint. If no initial Q is requested, the voltage setpoint can be biased by the initial Q before it is sent to the PPC. If a non-zero deadband is included in the voltage controller, the deadband can also be considered in the voltage setpoint sent to the PPC.

[11] Performance testing is recommended with a POI level SCR of 2.5 as this is a representative system condition seen during weak system studies. Testing may be performed at higher SCRs if the stable operating SCR of a model is known to be above 2.5.

	POI level SCR of 2.5. (Various systems may have specific speed requirements, which should be met)		
6d	Model responds to a step change in PPC active power setpoint, reaching 90% of the new value between 1 and 10 seconds in a test system with POI level SCR of 2.5.[12]		
Basic protection verification[13]			
7a	Protection settings are implemented. These could be available as inputs in the model, or hard-coded in the black-boxed controls. [14]		
7b	Option to disable protection models is present.[15]		
7c	Model trips or blocks when terminal voltage rises above 1.3 pu for 1 second.[16]		
7d	Model trips or blocks when terminal voltage falls below 0.2 pu for 1 second.[16]		
Documentation			
8a	Model documentation states compliance with "Recommended PSCAD model requirements Rev. 6, Electranix, June 21, 2019"[17], or is supplied with a completed PSCAD Model Requirements Supplier Checklist.		
8b	Model documentation includes instructions for setup and running of the model.		

[12] Different response time criteria may apply depending on specific interconnection region.
[13] There are many protection functions which should be modelled, per footnote 1, and these basic tests will not be proof that these are modelled.
[14] If settings are not visible in model or documentation, verification that protection settings are implemented in the PSCAD model should be received from the manufacturer.
[15] Non-compliance may not require model revision as many studies do not require testing with protection settings disabled.
[16] Non-compliance with this item should result in verification of protection settings implementation from the manufacturer, as some models may have capabilities beyond what is listed here.
[17] Non-compliance may be waived in systems which do not require compliance with the model requirements document.