**OEDI Task 3 Documentation – Transient Data Generation**

*Transient Use Case 3.a – Data Generation – IEEE 123xx Bus System with Distributed PVs*

**Model Selection**

This document serves as a guideline for transient use case data generation using the *IEEE123\_PV.atp* model example from the local OEDI repository. The user may first select the appropriate folder labeled by the system network model (in ATP-EMTP) format and download the corresponding zip file containing affiliated circuit data, topology zoning info and any other pertinent project files (.atp, .py, .txt, .rar, etc.).

Details of the network base case *IEEE 123xx* system with solar PV are given below:



**Steady State Settings**

After extraction of the model zip folder into a local directory, the user may select between several *IEEE123\_PV.atp* circuit files, each representing the same base network, but exhibiting a different **loading condition** and **solar PV capacity.** The base case (default) ATP file using 90% loading and 100% PV capacity is labeled *IEEE123\_PV\_net.atp*. See Table 1 below with a description of the various ATP steady-state (ss) cases available to the user for the IEEE123 bus network.

|  |  |  |
| --- | --- | --- |
| **ATP File** | **Total Load Multiplier** | **Total Solar PV Capacity** |
| IEEE123\_PV\_net.atp | 90% | 100% |
| IEEE123\_PV\_L1C1\_net.atp | 36% | 20% |
| IEEE123\_PV\_L1C2\_net.atp | 36% | 100% |
| IEEE123\_PV\_L2C1\_net.atp | 63% | 20% |
| IEEE123\_PV\_L2C2\_net.atp | 63% | 100% |
| IEEE123\_PV\_L3C1\_net.atp | 90% | 20% |
| IEEE123\_PV\_L3C2\_net.atp | 90% | 100% |

Table IEEE123 Bus Circuit SS Configurations

By brief examination of the *IEEE123\_PV.atp* file (see line 13), you can see that this file is used to call the default case, but may be substituted using one of the above detailed .atp circuit files. Thus, the user may edit this line using a general text editor to call any of the other configuration files in place of the base case.

**Transient State Settings**

Next, the user may select preferred simulation transient settings, i.e. fault types and locations or select the default settings. These parameters may be reconfigured via manipulation of the python script *ATPLoopFaults\_all\_IEEE123\_PV.py* or left as is for a default case study. This file is designed to run all fault types (L-G, LL-G, LLL-G) in all zones of the network. If the user wishes to run the default scenario, simply edit the necessary file paths, zone names and .pl4 destination folders for any particular zone. Otherwise, some editing of python script is required (discussed below). Additional python scripts *ATPLoopFaults\_xph\_IEEE123\_PV.py* are also available for running single phase faults only (A, B, or C). The following section describes the main default case file, provides a brief explanation of the code and its purpose, and highlights locations which may be edited by the user to customize fault settings prior to execution.

Transient Settings - *ATPLoopFaults\_all\_IEEE123\_PV.py*

* no\_sims - sets the number of randomized fault simulations.
* run\_atp\_fault\_case()- sets the fault parameters and runs the ATP file
  + Fault timing (line 23) - *tfault = random.uniform(0.15, 0.15 + 1/60)* creates a fault on a cycle sampled from a uniform distribution over the interval (, ) in seconds.
  + ATP write parameters (lines 26-30) writes to ATP the fault parameter and simulation timing, e.g. *print(‘\_\_\_\_TMAX =0.40, file=fp)*sets a 0.4 sec maximum simulation time.
  + Fault types (lines 31 – 80) – delineates conditionals to fault execution into ATP as L-G, LL-G, or LLL-G using (‘\_TFAULTx\_\_ = {:.5f}’.format(tfault), file=fp)for the associated phase x=A,B or C - where the fault is set to occur.

The user must set directory paths to the ATP files using atp\_path and an output path to store the .pl4 files created using pl4path. An accompanying .csv file in the models folder *zone\_info\_IEEE123\_PV\_v2.csv* contains all zones of the network, set by the zones variable read via Pandas, while the specific zone selected by the user in zone=zones.zone\_xx from the .csv labels, runs a case study for the selected bus in that zone. Additional python script(s) included in the model folder create the .csv files and allow the user to manipulate their own zoning labels if preferred via zone\_classification\_IEEE123\_PVxx.py, and are not needed for running transient simulations. Having access to such a collection of files in one package allows the user to customize their code to simulate various fault types in different locations across the distribution network, while logging transient outputs.

Finally, in *ATPLoopFaults\_all\_IEEE123\_PV.py,* a for loop is used to access the zoning file at each iteration and randomly select a node/bus in the zone in which to perform the fault study. Since the network is an unbalanced, three phase distribution system, some buses will contain all three phases and others may contain only one or two phases. For example, in zone\_35, bus 11 contains all three phases, noted in the zoning file by ‘*11\_ABC’*, while bus 7 is only single phase, noted as ‘*7\_C’*. Similarly, in zone\_23, bus 44 has only two phases, noted as *‘44\_AC’*. The code inside the loop checks the phase count of the randomly selected bus and runs a maximum of seven fault cases (if three phase – LLL-G, LL-G, and L-G for each phase combination), three cases if the bus selected contains only two phases, or a minimum of one fault case if the bus selected is single phase only. For example, zone\_23 bus 44 contains only phases A & C, thus a double line-to-ground fault case with phases A and C is run, followed by two single line-to-ground fault cases (one for each phase A and C). After running the script, we recommend the user check the generated ATP transient output using the PlotXY package (in ATP directory) to load the .pl4 files and verify correct voltage and current waveforms based on the fault condition settings.

An example of the ATP transient waveform plots for a test case run in zone\_35 on bus 51 (three-phase) using the script *ATPLoopFaults\_all\_IEEE123\_PV.py* are shown below. As noted above, a three-phase fault is conducted initially, followed by three double line-to-ground faults for each phase combination (only BC shown) and three single line-to-ground faults for each phase (only A shown). Output files are plotted below using PlotXY.

Chart

Description automatically generated

Table Single Line-to-Ground Fault Phase A

A picture containing box and whisker chart

Description automatically generated

Table Double Line-to-Ground Fault Phases B,C

Graphical user interface, chart

Description automatically generated with medium confidence

Table Three phase Line-to-Ground Fault