



<https://doi.org/10.5281/zenodo.10449573>

## ONLINE AND OFFLINE OF THE STATE ESTIMATION WITH DIGSILENT POWERFACTORY (PART 2)

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**Abstract.** The second part of the main paper (part 1) is presented here. The process of state estimation is presented in the continuation of the main paper. Following that, an OPC simulation is demonstrated using (Object Linking and Embedding for Process Control). Using DIgSILENT PowerFactory software in a real network, this paper presents state estimation and time domain simulation results. The paper shows how DIgSILENT PowerFactory can be used instead of Matlab and C++ software to estimate the offline and online state of a real network.

**Keywords:** DIgSILENT PowerFactory (DIgSILENT), State estimation (SE), Time-domain simulation, OPC, MatrikonOPC

**چکیده:** بخش دوم مقاله اصلی یعنی قسمت ۱، در اینجا ارائه می‌شود. در این بخش، فرآیند تخمین حالت در ادامه مقاله اصلی آورده شده است. پس از آن، یک شبیه سازی OPC با استفاده از " پیوند شی و جاسازی برای کنترل فرآیند " نشان داده شده است. این مقاله با استفاده از نرم افزار دیجسایلنت پاورفکتوری در یک شبکه واقعی، تخمین حالت و نتایج شبیه سازی دامنه زمانی را ارائه کرده است. این مقاله نشان می‌دهد که چگونه می توان از نرم افزار دیجسایلنت پاورفکتوری به جای نرم افزارهای Matlab و ++C در تخمین حالت آفلاین و آنلاین و در یک شبکه واقعی استفاده کرد.

**کلمات کلیدی:** نرم افزار دیجسایلنت، تخمین حالت، شبیه سازی زمانی، نرم افزار ماتریکون

### 5- Online time domain simulation

Online time domain simulation is another requirement of power company operators. The used software must be able to load flow and state estimation in online mode. In addition to performing load flows, state estimations, and time domain simulations, the software also provides a remote and online option. In order to achieve this, we need the following software and hardware [15-16]:

- \*- DIgSILENT software (available at most regional electricity and distribution companies)
- \*- You can download MatrikonOPC Simulation Server simulator software from the Matrikon website (matrikonopc.com) [15-16].
- \*- A preferably 64-bit computer

You can now easily perform the required simulations online by following the steps below. You can use the attachment for more explanations in each part: (A1-1- Online TDS (Time Domain Simulation), A1-2- OnLine Dispatcher Load Flow, A1-3-Online State Estimation).

Step 1: Matrikon software must be installed first to define signals and measurements at the entire network level in order to be able to view calculated values and send commands [16].

Step 2: Create a CSV file with all the controllers and meters listed, such as cubicle 3 bus 7 (PF. SWT\_BUS\_7\_CUB\_3).

Step 3: Read a CSV file with Matrikon software and make the necessary changes to DIgSILENT.

Step 4: Implementation of the time domain simulation program of the studied network (computer number one)

Step 5: Opening and closing key 3 bus 7 in Matrikon software (computer number two)

Step 6: In DIgSILENT software (computer number one), it displays its momentary changes.

Through the network, two software programs installed on two computers are able to share information regarding the connection and disconnection of keys. The final result of Figure 5 shows that when the key code is changed from 0 to 1, computer number one, which is simulating in the time domain, sees and responds to these changes. Changing Matrikon software can be sent directly from the automation department of power companies to the main software of the power system. Load flow and state estimation can be performed similarly to time domain simulation, as explained in the appendix.

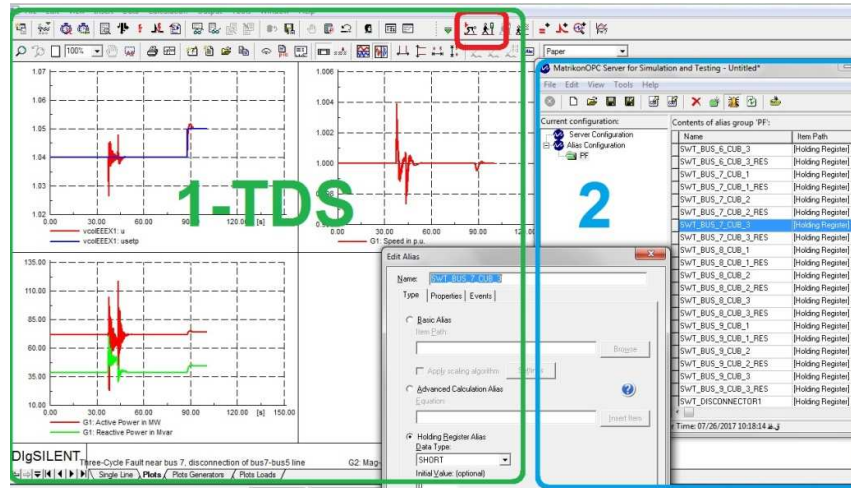


Fig. 5. Execution of instantaneous network control in remote DIgSILENT software online

It is also necessary to introduce an identification tag (TagID) for each measurement in order to facilitate information exchange. DIgSILENT requires the creation of a type of measurer called External DAT Measurement (StaExtatmea) in order to display information in Matrikon. All reactive and active power meters, as well as current and voltage identifiers, are introduced, and their names are listed in a CSV file. You can view the information online in Matrikon, and you can make changes after creating a list of meter names in DIgSILENT. A change in Matrikon's online load flow and online state estimation is also visible in DIgSILENT, as a result of the changes to each element.

## ONLINE AND OFFLINE OF THE STATE ESTIMATION WITH DIGSILENT POWERFACTORY (Part2)

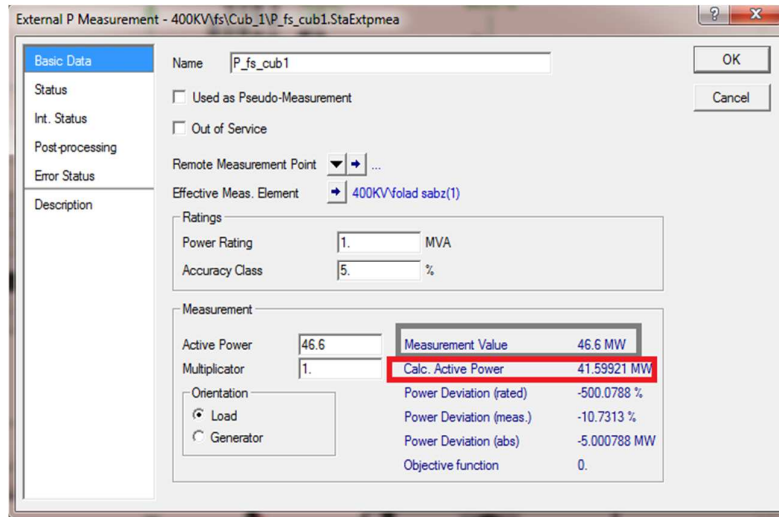


Fig. 6. An estimate of the active power of bus 22 in the first stage

Bus load 22 has an active power of 41.6 MW. In the first situation, the meter has incorrect information, and in the second situation, it has no information. First, the active power value of bus bar 22 is 46.6 MW, and second, it is placed in the out of service mode. The image below shows the estimated value with state estimation calculations (Figure 6) after identifying the location of the error and checking the calculations.

During the next step of measuring the active power of bus bar 22, it is placed out of service. The image below shows the estimated value with state estimation calculations after identifying the error location and checking the calculations (Figure 7).

Digsilent software is capable of estimating a meter's value and type when it sends the wrong information due to technical or telecommunication problems within the power network.

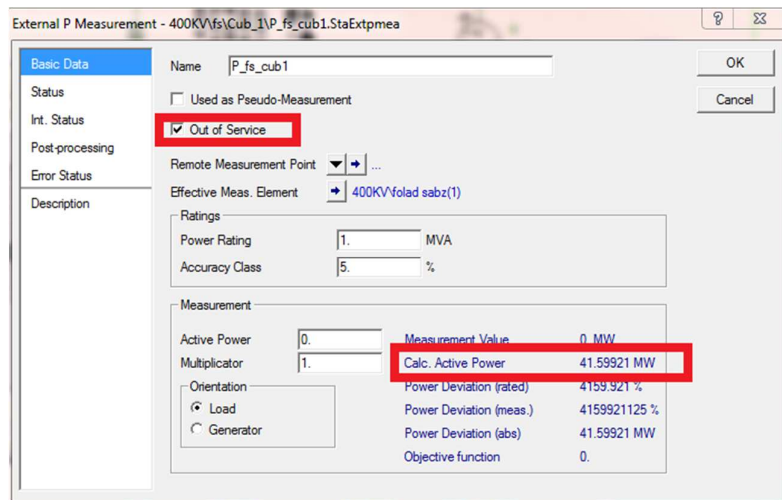


Fig. 7. An estimate of the active power of bus 22 in the second stage

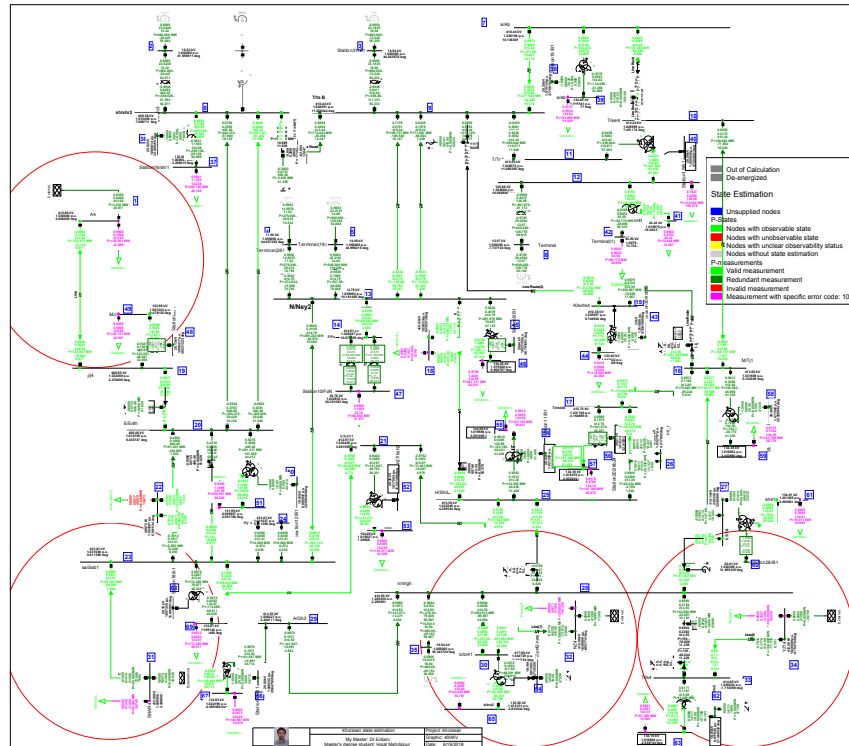


Fig. 8. State estimation result with error in all real power meters

In addition, it is assumed that all real power measurements are subject to error. Figure (8) shows the graphical representation of DlgSILENT software state estimation after changing the real power meter values of the loads by 2 MW. Although all the real power measurements of loads have errors, the state estimation algorithm is able to determine their correct values despite the errors.

## 6- Using DlgSILENT software to work online

### 6-1- Online TDS (Time Domain Simulation)

- 1- Install: MatrikonOPCSimulation.exe
- 2- Run: MatrikonOPC for Simulation
  - 2-1- File- Import Aliases: OPCServerCfg\_V005.csv
  - 2-2- Tick PF
- 3- Run: MatrikonOPC Explorer:
  - 3-1: Click: Matrikon.OPC.Simulation.1 (connect)
  - 3-2: Right Click: Add Group
  - 3-3: Group name: anything
  - 3-4: Tick Configured Aliases and then: PF
  - 3-5: Right-click in Available Tags
  - 3-6: Add All Items to Tag List
  - 3-7: Tick Close the items

## ONLINE AND OFFLINE OF THE STATE ESTIMATION WITH DIGSILENT POWERFACTORY (Part2)

### 4- Run: DIGSILENT

4-1- Tools, Configuration, Advanced, and Tick: Runtime Engine mode and Tick Enable Multi-Threading

4-2- In Data Manger Find (Link) in Study Case and double click (Fig. 9)

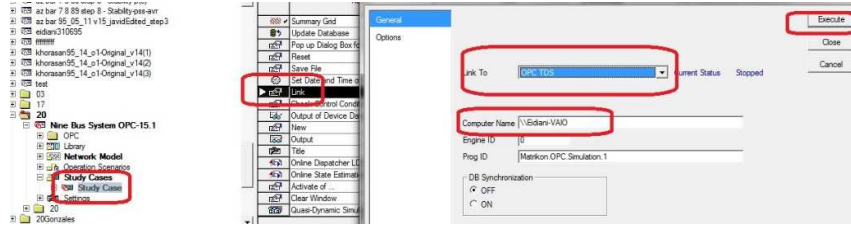


Fig. 9. Link Data Manager

4-3: See Fig. 10.

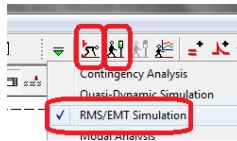


Fig. 10. See RMS/EMT Simulation

4-4: In MatrikonOPC Server find (SWT\_BUS\_7\_CUB\_3)

4-5: Change: Initial Value: 0 to 1 then to 0

4-6: See Fig. 11.

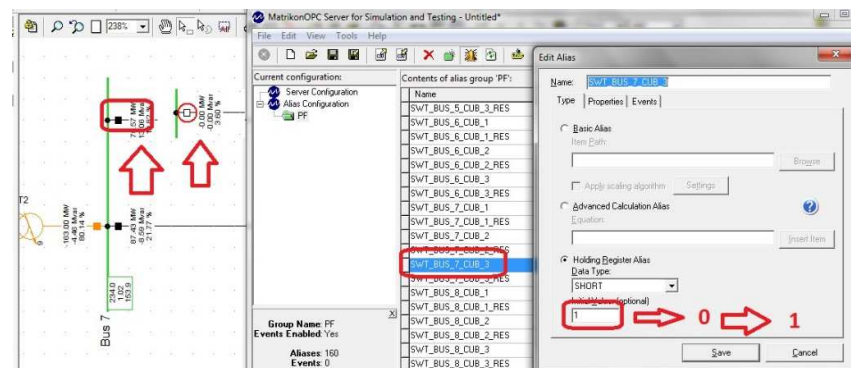


Fig. 11. See cubicle

4-7: END: See Fig. 12.

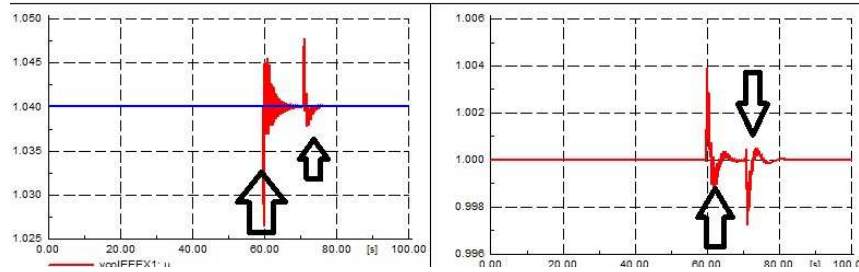


Fig. 12. See output

### 6-2-Online Dispatcher Load Flow

Continued from 4.2:

4-2- In Data Manger Find (Link) in Study Case and double click (Fig. 13.)

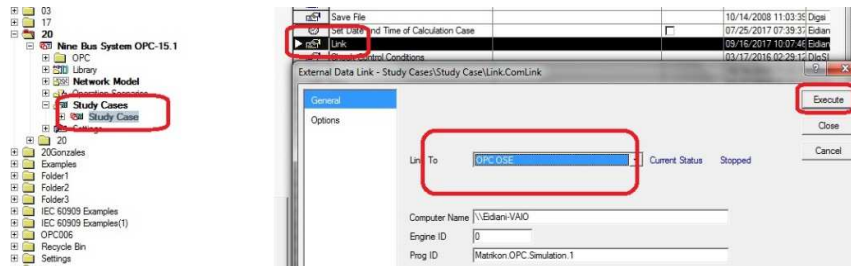


Fig. 13. See Link

4-3: Run: Online Dispatcher LDF (Fig. 14.)

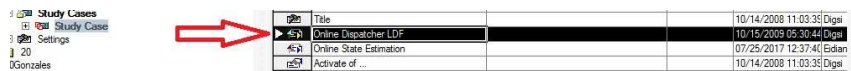


Fig. 14. See online dispatcher LDF

4-4: In MatrikonOPC Server find (SWT\_BUS\_7\_CUB\_3) (Fig. 15.)

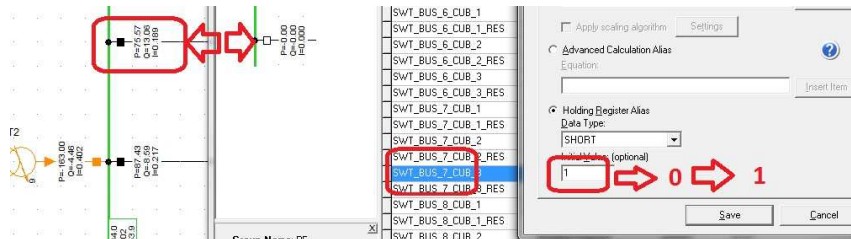


Fig. 15. See cubicle

### 6-3-Online State Estimation

Continued from 4.2:

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4-3: Run: Online State Estimation (Fig. 16.)

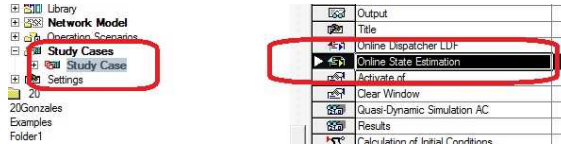


Fig. 16. See online state estimation

4-4: See Fig. 17.

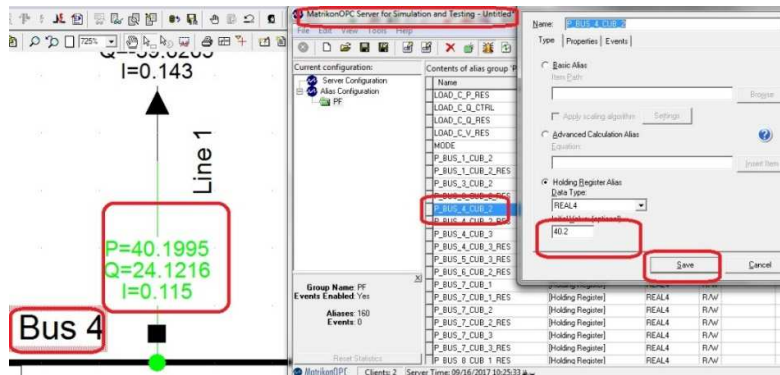


Fig. 17. See MatrikonOPC server for simulation

4-5: See Fig. 18.

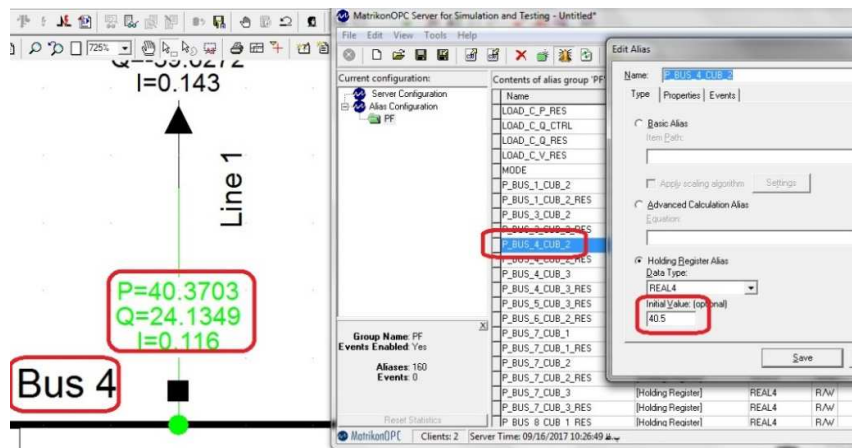


Fig. 18. See MatrikonOPC server for simulation

4-6: See Fig. 19.



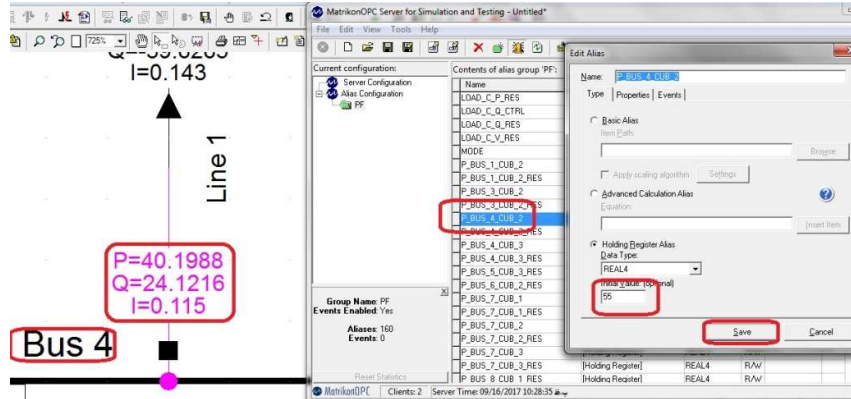


Fig. 19. See MatrikonOPC server for simulation

## 7- Using functions and files to read load information

See: (LOAD\_Measurement.txt) and (LOAD\_Measurement.pfd)

How can I control the power of a 3-phase load in a dynamic simulation using an external file in Technical Reference Documentation Measurement File?

1 – See Fig. 20.

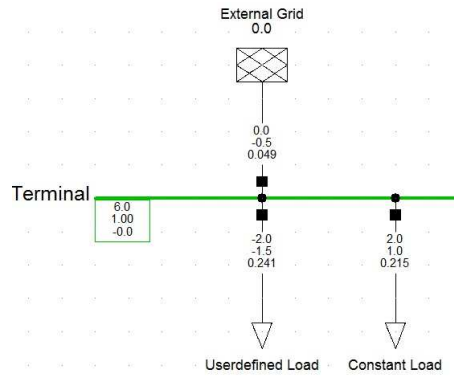


Fig. 20. See a simple system

2 – See Fig. 21.



ONLINE AND OFFLINE OF THE STATE ESTIMATION WITH DIGSILENT POWERFACTORY (Part2)

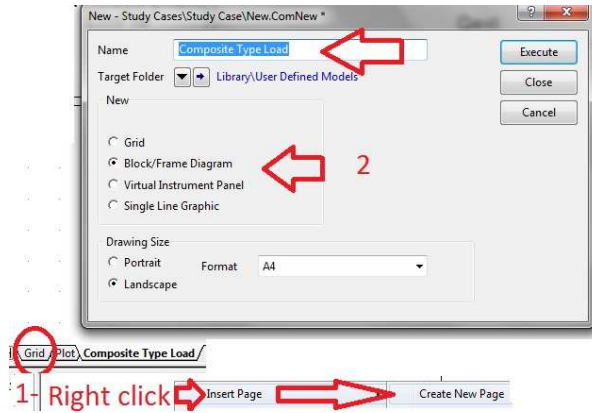


Fig. 21. See composite type load

3 – See Fig. 22.

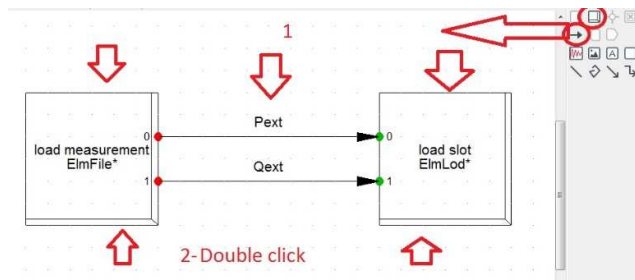


Fig. 22. Load measurement

4 – See Fig. 23.

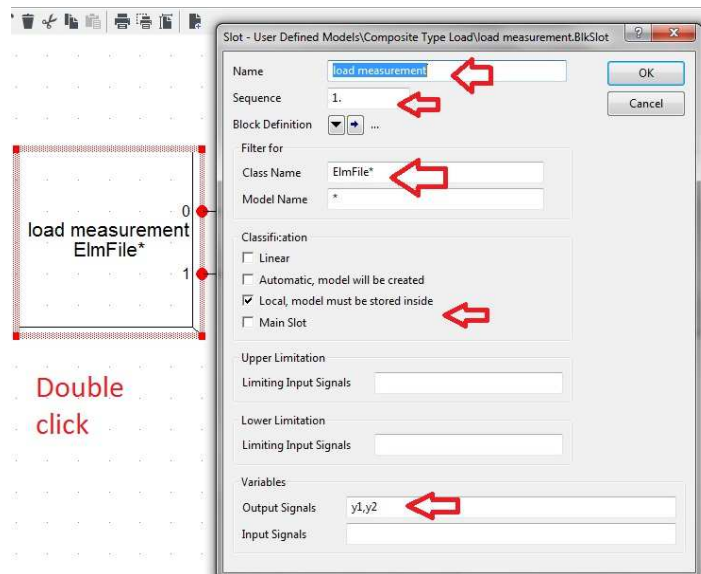


Fig. 23. See output signal

5 – See Fig. 24.

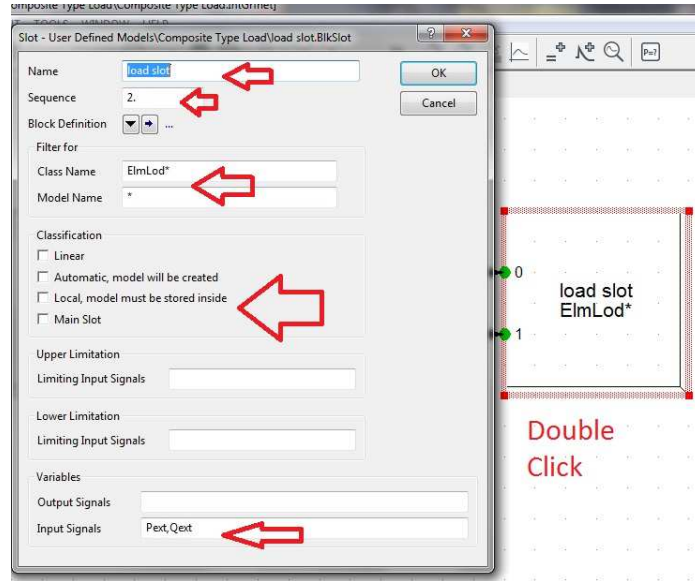


Fig. 24. See Input signals

6 – See Fig. 25.

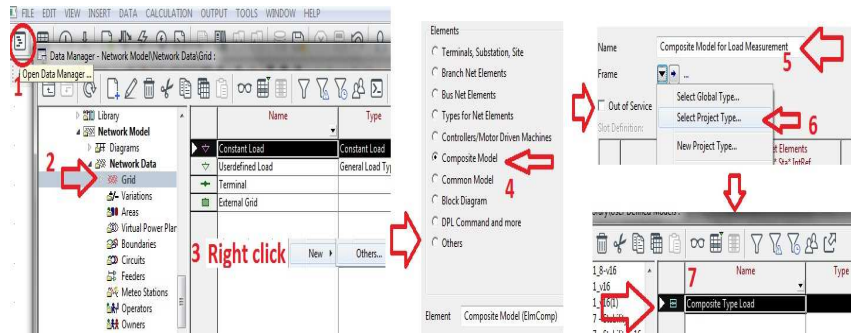


Fig. 25. Composite model for load

7 – See Fig. 26.

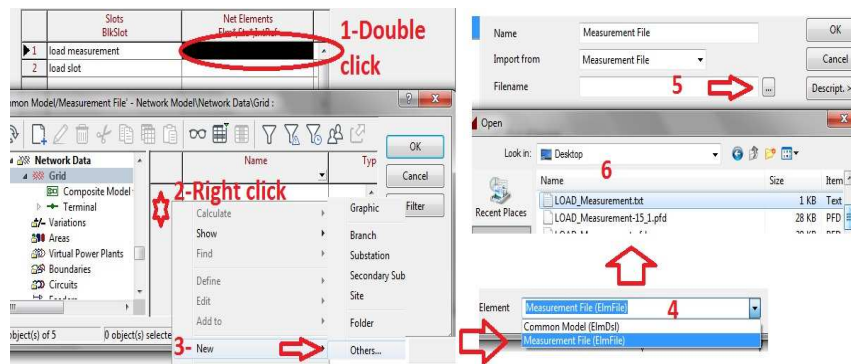


Fig. 26. Load “load measurement” file

8 – See Fig. 27.

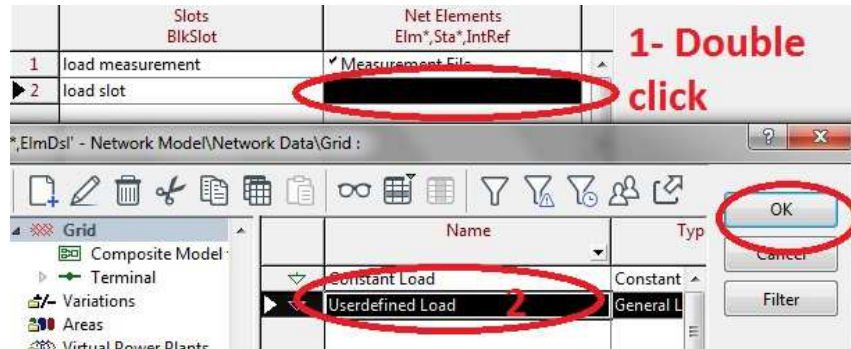


Fig. 27. See user define load

9 – See Fig. 28.

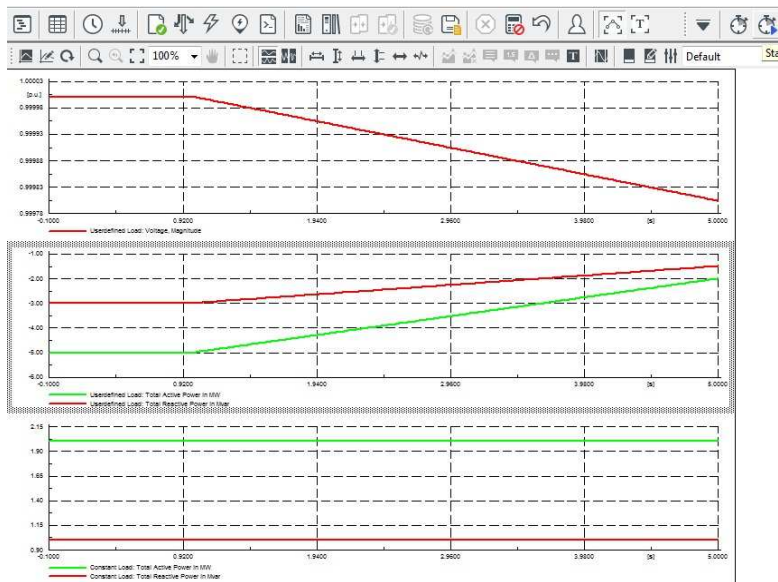


Fig. 28. See the output of the program

### 8- Entering time-varying information for loads or meters in all programs, including state estimation

Load: LoadCurve.txt

Time; LoadByFile 1;LoadByFile 2;LoadByFile 3

2016.01.01 00.00.00;0,9000;0,9546;0,228

2016.01.01 00.30.00;0,2149;0,9461;0,2149

All variables, including line length, power measurement values, voltage, and loads, can be calculated using the following steps.

1 – See Fig. 29.



Fig. 29. See active power

2 – See Fig. 30.

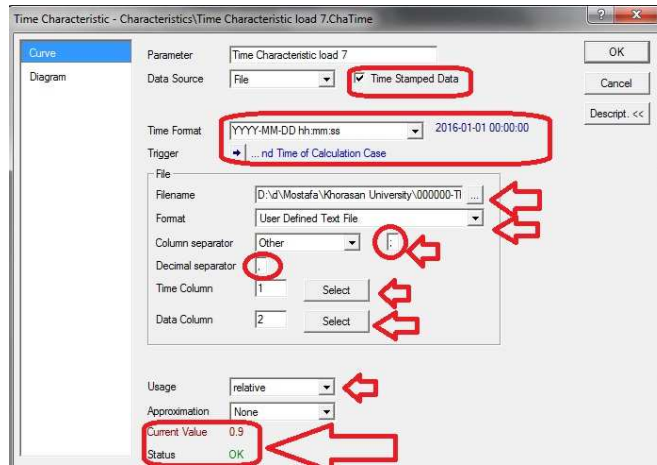


Fig. 30. See time characteristic

3 – See Fig. 31.

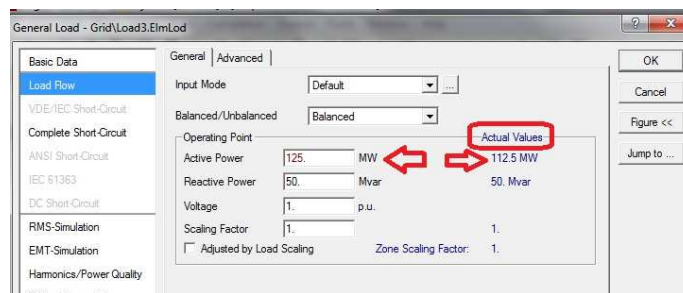


Fig. 31. See Active value

4 – See Fig. 32.

Name	Grid	Act. Pow. MW	Current Value MW	Minutes
Load3	Grid	125.	112.5	Time Characteristic load 7
Load4	Grid	90.	90.	Time Characteristic load 7
Load7	Grid	100.	90.	Time Characteristic load 7

Fig. 32. See time characteristic load

5- See Fig. 33.

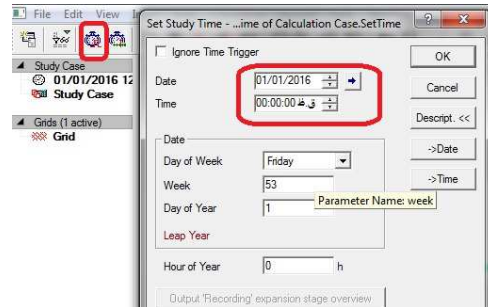


Fig. 33. See date and time

## 9- Conclusion

Among the most important practical challenges in power system operation is the estimation of state in power systems, a problem Digsilent solves. It was demonstrated in this paper that the use of state estimation programs should take cyber security into account first. In addition to estimating online and offline without needing additional software, professional software can also be used to generate estimates automatically. Moreover, simulations allow operators to make more informed decisions based on network information because they provide more accurate data.

## References

- [1] M. Eidiyani, A rapid state estimation method for calculating transmission capacity despite cyber security concerns. IET Gener. Transm. Distrib. 1–9 (2023). <https://doi.org/10.1049/gtd2.12747>
- [2] M. Eidiyani, H. Zeynal, A. K. Zadeh and K. M. Nor, "Exact and efficient approach in static assessment of Available Transfer Capability (ATC)," 2010 IEEE International Conference on Power and Energy, 2010, pp. 189-194, doi: 10.1109/PECON.2010.5697580.
- [3] M. Eidiyani and H. Zeynal, "A Fast Holomorphic Method to Evaluate Available Transmission Capacity with Large Scale Wind Turbines," 2022 9th Iranian Conference on Renewable Energy & Distributed Generation (ICREDG), 2022, pp. 1-5, doi: 10.1109/ICREDG54199.2022.9804527.
- [4] M. Eidiyani, H. Zeynal and Z. Zakaria, "An Efficient Holomorphic Based Available Transfer Capability Solution in Presence of Large Scale Wind Farms," 2022 IEEE International Conference in Power Engineering Application (ICPEA), 2022, pp. 1-5, doi: 10.1109/ICPEA53519.2022.9744711.
- [5] H. Zeynal, Y. Jiazhen, B. Azzopardi and M. Eidiyani, "Flexible economic load dispatch integrating electric vehicles," 2014 IEEE 8th International Power Engineering and Optimization Conference (PEOCO2014), 2014, pp. 520-525, doi: 10.1109/PEOCO.2014.6814484.
- [6] M. Eidiyani, H. Zeynal, A. K. Zadeh, S. Mansoorzadeh and K. M. Nor, "Voltage stability assessment: An approach with expanded Newton Raphson-Sydel," 2011 5th International Power Engineering and Optimization Conference, 2011, pp. 31-35, doi: 10.1109/PEOCO.2011.5970424.

- [7] M. Eidiyani, "A reliable and efficient method for assessing voltage stability in transmission and distribution networks", *International Journal of Electrical Power and Energy Systems*, 2011, 33(3), pp. 453–456, DOI: 10.1016/j.ijepes.2010.10.007
- [8] M. Eidiyani, M., "A New Method for Assessment of Voltage Stability in Transmission and Distribution Networks", *International Review of Electrical Engineering*, 2010, 5(1), pp. 234–240, January-February 2010.
- [9] M. Eidiyani, Y. Ashkhane and M. Khederzadeh, "Reactive Power Compensation in Order to Improve Static Voltage Stability in a Network with Wind Generation," 2009 International Conference on Computer and Electrical Engineering, ICCEE 2009, 2009, 1, pp. 47–50, 5380672, doi: 10.1109/ICCEE.2009.239.
- [10] M. Eidiyani, "Assessment of voltage stability with new NRS," 2008 IEEE 2nd International Power and Energy Conference, 2008, pp. 494-496, doi: 10.1109/PECON.2008.4762525.
- [11] M. Eidiyani, M., M.O. Buygi, S. Ahmadi, "CTV, complex transient and voltage stability: A new method for computing dynamic ATC", *International Journal of Power and Energy Systems*, 2006, 26(3), pp. 296–304, <https://doi.org/10.2316/Journal.203.2006.3.203-3597>, 2006.
- [12] M. Eidiyani and M. Kargar, "Frequency and voltage stability of the microgrid with the penetration of renewable sources," 2022 9th Iranian Conference on Renewable Energy & Distributed Generation (ICREDG), 2022, pp. 1-6, doi: 10.1109/ICREDG54199.2022.9804542.
- [13] M. Eidiyani, M.H.M. Shanechi, "FAD-ATC: A new method for computing dynamic ATC", *International Journal of Electrical Power and Energy Systems*, 2006, 28(2), pp. 109–118, Feb. 2006, <https://doi.org/10.1016/j.ijepes.2005.11.004>, 2006.
- [14] H. Zeynal, L. X. Hui, Y. Jiazhen, M. Eidiyani and B. Azzopardi, "Improving Lagrangian Relaxation Unit Commitment with Cuckoo Search Algorithm," 2014 IEEE International Conference on Power and Energy (PECon), 2014, pp. 77-82, doi: 10.1109/PECON.2014.7062417.
- [15] H. Zeynal, Y. Jiazhen, B. Azzopardi and M. Eidiyani, "Impact of Electric Vehicle's integration into the economic VAR dispatch algorithm," 2014 IEEE Innovative Smart Grid Technologies - Asia (ISGT ASIA), 2014, pp. 780-785, doi: 10.1109/ISGT-Asia.2014.6873892.
- [16] H. Zeynal and M. Eidiyani, "Hydrothermal scheduling flexibility enhancement with pumped-storage units," 2014 22nd Iranian Conference on Electrical Engineering (ICEE), 2014, pp. 820-825, doi: 10.1109/IranianCEE.2014.6999649.
- [17] M. Eidiyani, H., Zeynal, "New approach using structure-based modeling for the simulation of real power/frequency dynamics in deregulated power systems", *Turkish Journal of Electrical Engineering and Computer Sciences*, 2014, 22(5), pp. 1130–1146, <https://doi.org/10.3906/elk-1208-90>.
- [18] M.E. Baydokhty, M. Eidiyani, H. Zeynal, H. Torkamani, H. Mortazavi, "Efficient Generator Tripping Approach with Minimum Generation Curtailment based on Fuzzy System Rotor Angle Prediction", *Przegląd Elektrotechniczny*, 2012, 88(9 A), pp. 266–271.
- [19] M. Eidiyani, M.E. Badokhty, M. Ghamat, H. Zeynal, "Improving Transient Stability Using Combined Generator Tripping and Braking Resistor Approach", *International Review on Modelling and Simulations*, 2011, 4(4), pp. 1690–1699.
- [20] M. Eidiyani, M. Ebrahimean Baydokhty, M. Ghamat, H. Zeynal and H. Mortazavi, "Transient stability enhancement via hybrid technical approach," 2011 IEEE Student Conference on Research and Development, 2011, pp. 375-380, doi: 10.1109/SCORed.2011.6148768.
- [21] M. Eidiyani, N. Asghari Shahdehi and H. Zeynal, "Improving dynamic response of wind turbine driven DFIG with novel approach," 2011 IEEE Student Conference on Research and Development, 2011, pp. 386-390, doi: 10.1109/SCORed.2011.6148770.
- [22] H. Zeynal, A.K. Zadeh, K.M Nor, M. Eidiyani, "Locational Marginal Price (LMP) Assessment Using Hybrid Active and Reactive Cost Minimization", *International Review of Electrical Engineering*, 2010, 5(5), pp. 2413–2418, Oct. 2010.
- [23] M. Eidiyani, M. H. M. Shanechi and E. Vaahedi, "Fast and accurate method for computing FCTTC (first contingency total transfer capability)," *Proceedings. International Conference on Power System Technology*, 2002, pp. 1213-1217 vol.2, doi: 10.1109/ICPST.2002.1047595.
- [24] M. Eidiyani, "Atc evaluation by CTSA and POMP, two new methods for direct analysis of transient stability," *IEEE/PES Transmission and Distribution Conference and Exhibition*, 2002, pp. 1524-1529 vol.3, doi: 10.1109/TDC.2002.1176824.
- [25] G. Ghardashi, M. Gandomkar, S. Majidi, M. Eidiyani and S. Dadfar, "Accuracy and Speed Improvement of Microgrid Islanding Detection based on PV using Frequency-Reactive Power Feedback Method," 2022 International



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- Conference on Protection and Automation of Power Systems (IPAPS), 2022, pp. 1-8, doi: 10.1109/IPAPS55380.2022.9763190.
- [26] M. Eidiyani and A. Ghavami, "New network design for simultaneous use of electric vehicles, photovoltaic generators, wind farms and energy storage," 2022 9th Iranian Conference on Renewable Energy & Distributed Generation (ICREDG), 2022, pp. 1-5, doi: 10.1109/ICREDG54199.2022.9804534.
- [27] M. Eidiyani, H. Zeynal, Z. Zakaria, M. Shaaban, "A Comprehensive Study on the Renewable Energy Integration Using DigSILENT", 2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA), 1570860205, 6-7 March 2023.
- [28] M. Eidiyani, H. Zeynal and M. Shaaban, "A Detailed Study on Prevailing ATC Methods for Optimal Solution Development," 2022 IEEE International Conference on Power and Energy (PECon), 2022, pp. 299-303, doi: 10.1109/PECon54459.2022.9988775.
- [29] M. Eidiyani, H. Zeynal, A. Ghavami and Z. Zakaria, "Comparative Analysis of Mono-Facial and Bifacial Photovoltaic Modules for Practical Grid-Connected Solar Power Plant Using PVsyst," 2022 IEEE International Conference on Power and Energy (PECon), 2022, pp. 499-504, doi: 10.1109/PECon54459.2022.9988872.
- [30] M. Eidiyani, H. Zeynal, Z. Zakaria, M. Shaaban, "Analysis of Optimization Methods Applied for Renewable Energy Integration", 2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA), 1570861924, 6-7 March 2023.
- [31] M. Eidiyani, Applying Optimization Techniques to Develop a Renewable Energy Supply Map. In: Fathi, M., Zio, E., Pardalos, P.M. (eds) Handbook of Smart Energy Systems. Springer, Cham. [https://doi.org/10.1007/978-3-030-72322-4\\_61-1](https://doi.org/10.1007/978-3-030-72322-4_61-1)
- [32] Z. Zand, M.R. Ghahri, S. Majidi, M. Eidiyani, M.A. Nasab, M. Zand, M. Smart Grid and Resilience. In: Fathi, M., Zio, E., Pardalos, P.M. (eds) Handbook of Smart Energy Systems. Springer, Cham. [https://doi.org/10.1007/978-3-030-72322-4\\_178-1](https://doi.org/10.1007/978-3-030-72322-4_178-1)
- [33] S. Momen, A. Hekmati, S. Majidi, Z. Zand, M. Zand, J. Nikoukar, M. Eidiyani, Energy Harvesting for Smart Energy Systems., Handbook of Smart Energy Systems. Springer, Cham. [https://doi.org/10.1007/978-3-030-72322-4\\_12-1](https://doi.org/10.1007/978-3-030-72322-4_12-1)
- [34] M. Eidiyani, Integration of Renewable Energy Sources. In: Fathi, M., Zio, E., Pardalos, P.M. (eds) Handbook of Smart Energy Systems. Springer, Cham. [https://doi.org/10.1007/978-3-030-72322-4\\_41-1](https://doi.org/10.1007/978-3-030-72322-4_41-1)
- [35] M. Eidiyani, H. Zeynal and Z. Zakaria, "An Efficient Method for Available Transfer Capability Calculation Considering Cyber-Attacks in Power Systems," 2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA), Putrajaya, Malaysia, 2023, pp. 127-130, doi: 10.1109/ICPEA56918.2023.10093168.
- [36] M. Eidiyani, H. Zeynal and Z. Zakaria, "A Comprehensive Study on The Renewable Energy Integration Using DigSILENT," 2023 IEEE 3rd International Conference in Power Engineering Applications (ICPEA), Putrajaya, Malaysia, 2023, pp. 197-201, doi: 10.1109/ICPEA56918.2023.10093153.
- [37] M. Eidiyani, H. Zeynal, "An Effective Method to Determine the Available Transmission Capacity with Variable Frequency Transformer", International Transactions on Electrical Energy Systems, vol. 2023, Article ID 8404284, 10 pages, 2023. <https://doi.org/10.1155/2023/8404284>.