



## 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 DlgSILENT PowerFactory software in a real network, this paper presents state estimation and time domain simulation results. The paper shows how DlgSILENT PowerFactory can be used instead of Matlab and C++ software to estimate the offline and online state of a real network.

**Keywords:** DlgSILENT PowerFactory (DLgSILENT), 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]:

\*- DlgSILENT 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 DlgSILENT.

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.

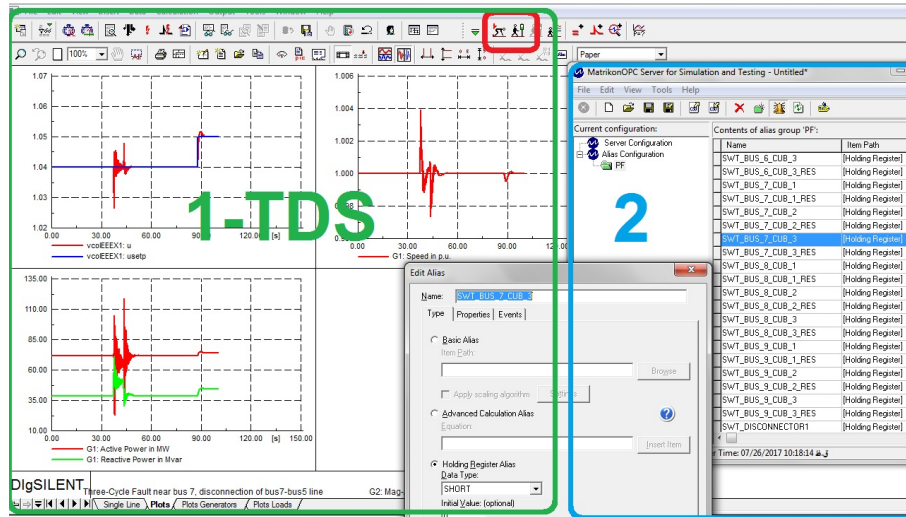


Fig. 5. Execution of instantaneous network control in remote DIGSILENT software online

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 (StaExtdatmea) 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)

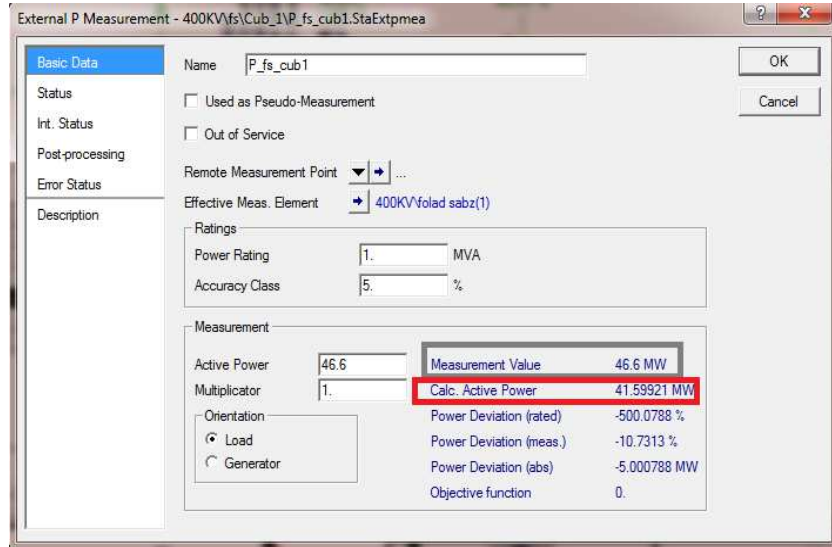


Fig. 6. An estimate of the active power of bus 22 in the first stage

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.

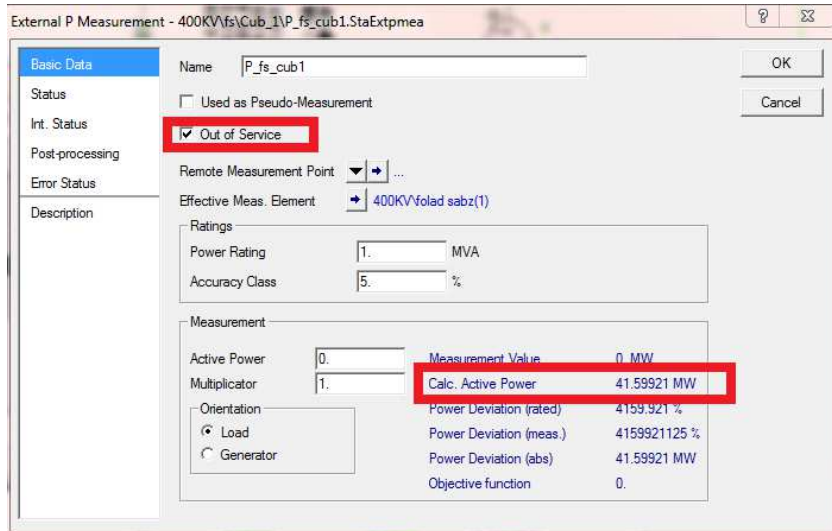


Fig. 7. An estimate of the active power of bus 22 in the second stage

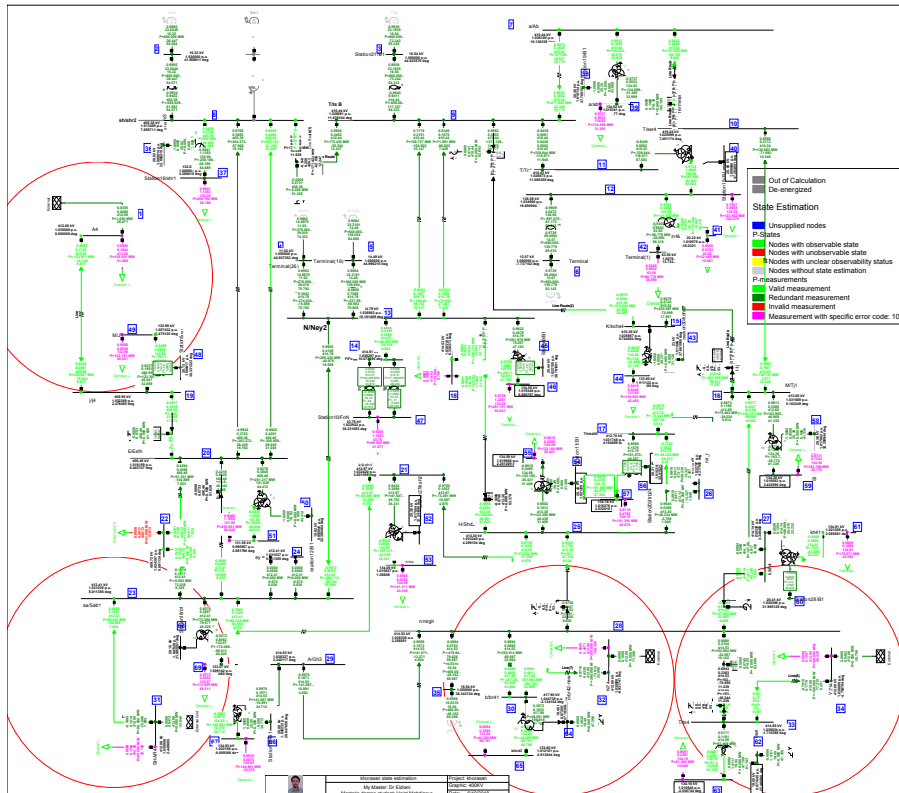


Fig. 8. State estimation result with error in all real power meters

In addition, it is assumed that all real power measurements are subject to error. Figure (8) shows the graphical representation of DIgSILENT 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 DIgSILENT software to work online

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

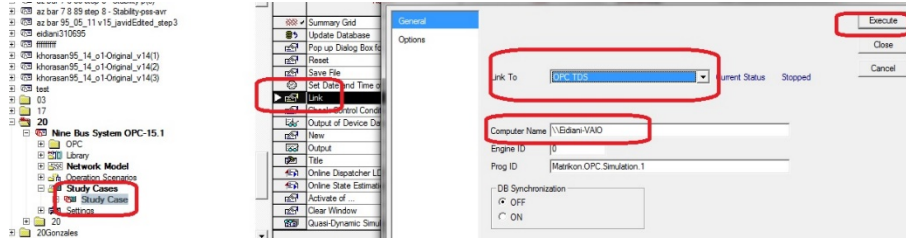
- 1- Install: MatrikonOPCSimulation.exe
- 2- Run: MatrikonOPC for Simulation
  - 2-1- File- Import Aliases: OPCServerCfg\_V005.csv
  - 2-2- Tick PF
- 3- Run: MatrikonOPC Explorer:
  - 3-1: Click: Matrikon.OPC.Simulation.1 (connect)
  - 3-2: Right Click: Add Group
  - 3-3: Group name: anything
  - 3-4: 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

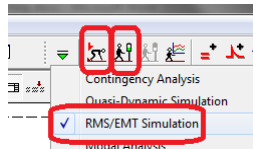
4-1- Tools, Configuration, Advanced, and Tick: Runtime Engine mode and Tick Enable Multi-Threading

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.

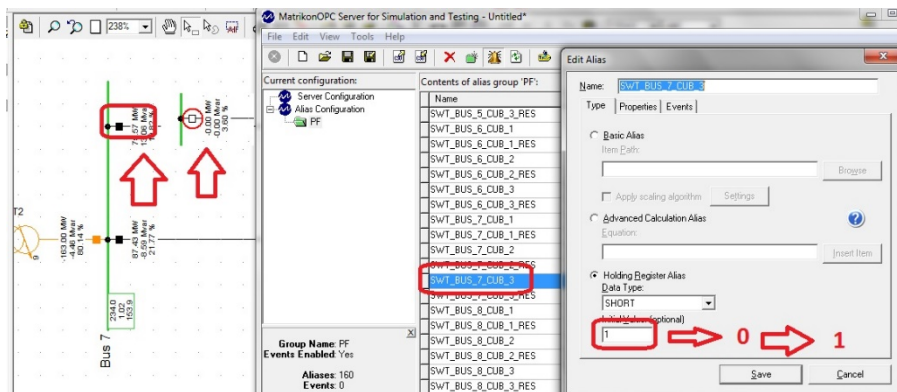


**Fig. 10.** See RMS/EMT Simulation

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.

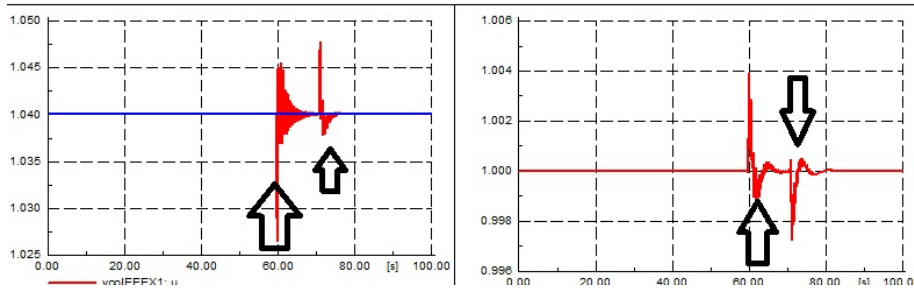


Fig. 12. See output

### 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.)

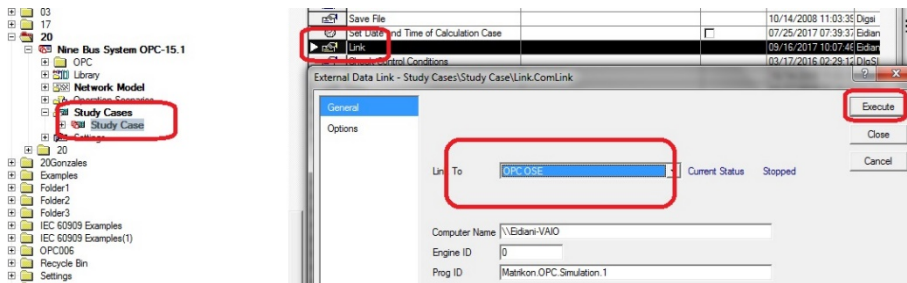


Fig. 13. See Link

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

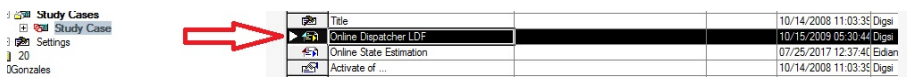


Fig. 14. See online dispatcher LDF

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

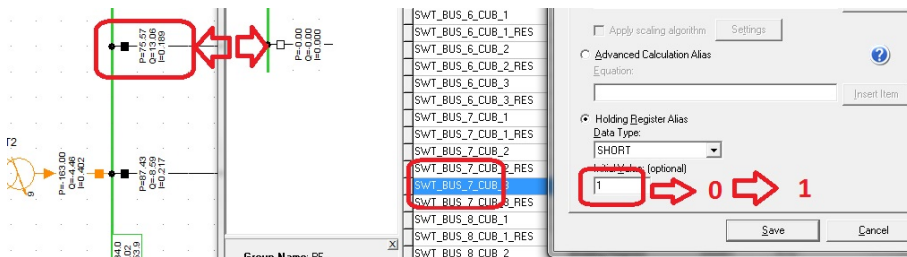


Fig. 15. See cubicle

### 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.

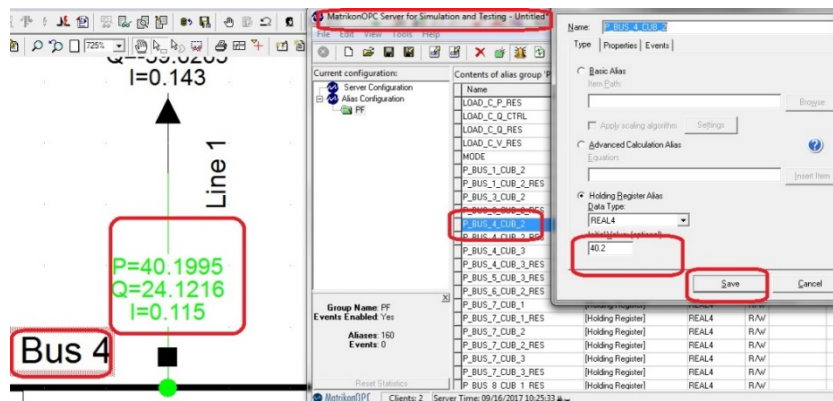


Fig. 17. See MatrikonOPC server for simulation

4-5: See Fig. 18.

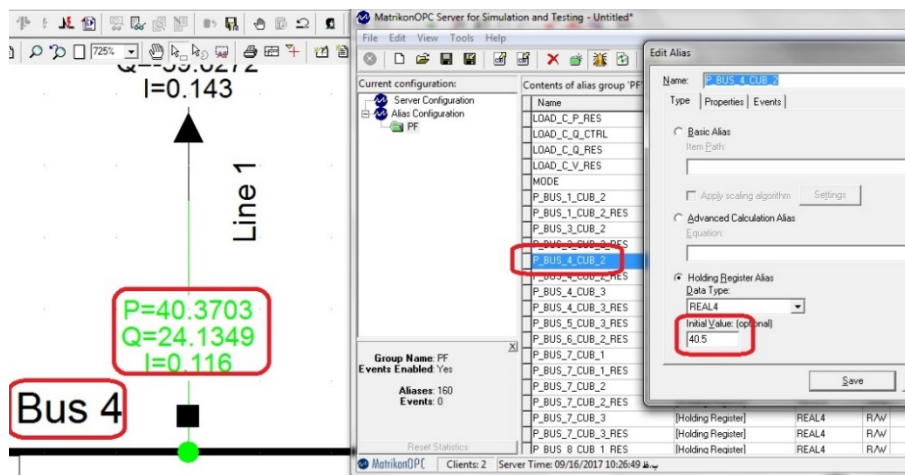


Fig. 18. See MatrikonOPC server for simulation

4-6: See Fig. 19.

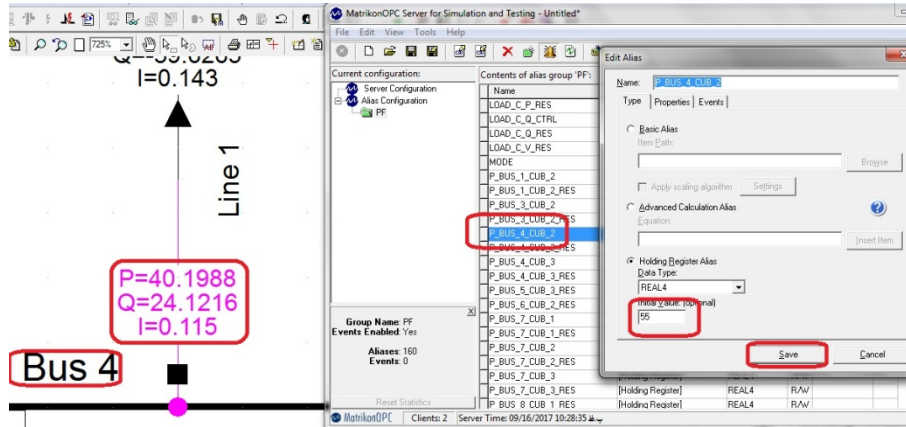


Fig. 19. See MatrikonOPC server for simulation

### 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.

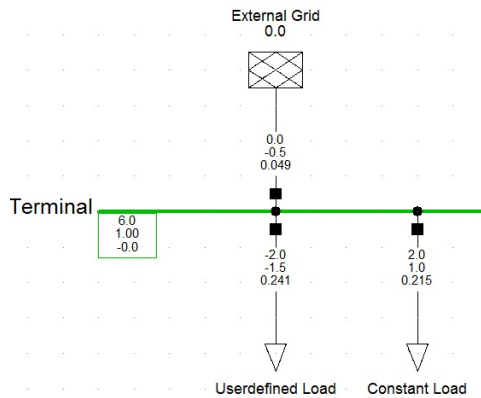
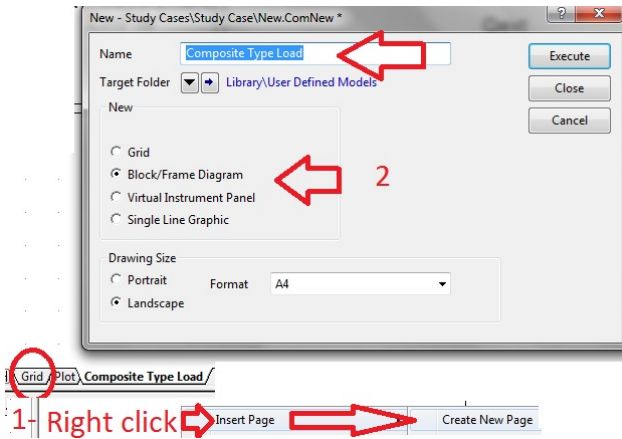


Fig. 20. See a simple system

2 – See Fig. 21.

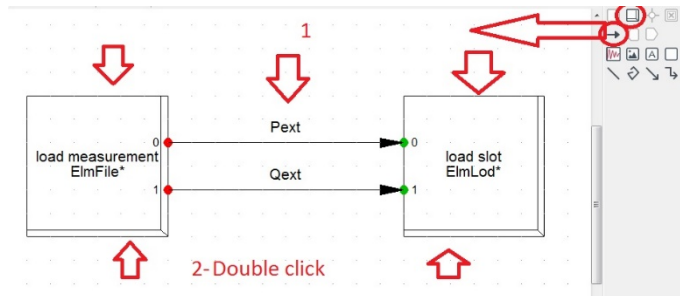


**ONLINE AND OFFLINE OF THE STATE ESTIMATION WITH DIGSILENT POWERFACTORY (Part2)**



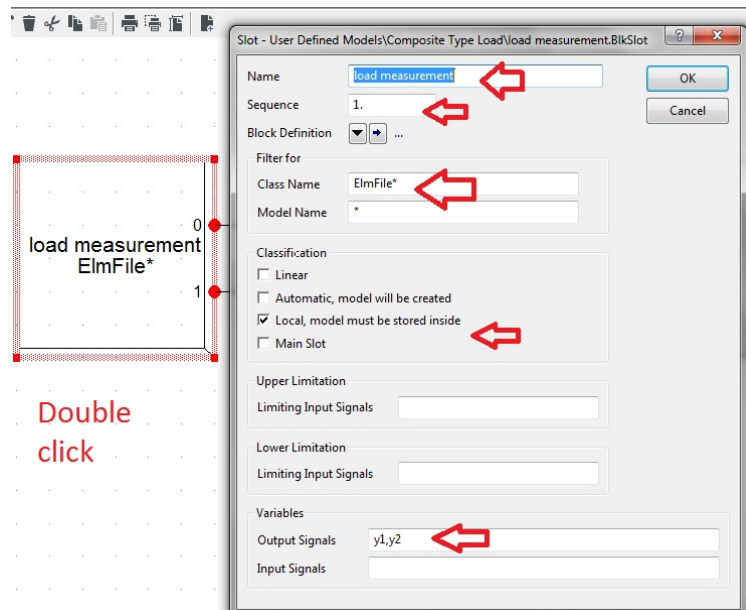
**Fig. 21.** See composite type load

3 – See Fig. 22.



**Fig. 22.** Load measurement

4 – See Fig. 23.



**Fig. 23.** See output signal

5 – See Fig. 24.

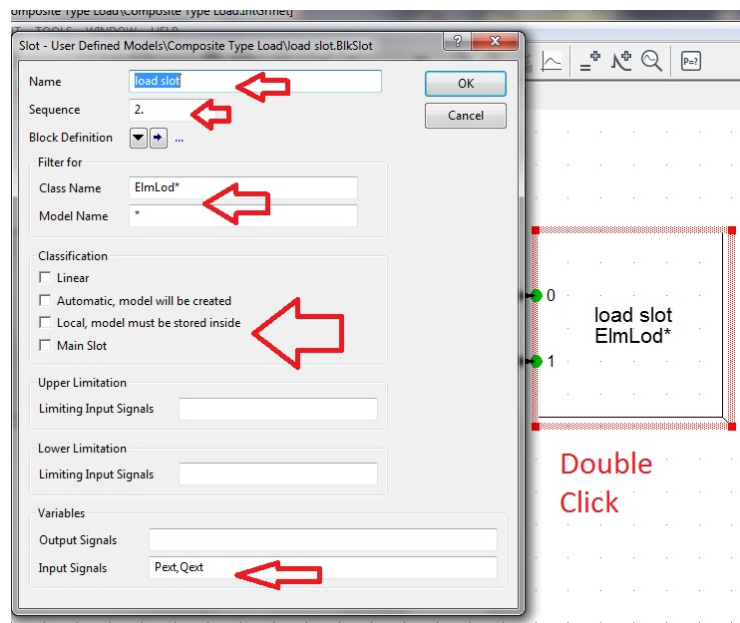


Fig. 24. See Input signals

6 – See Fig. 25.

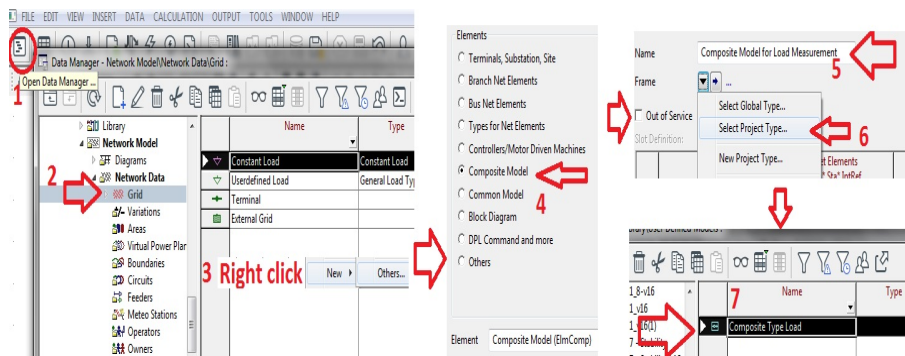


Fig. 25. Composite model for load

7 – See Fig. 26.

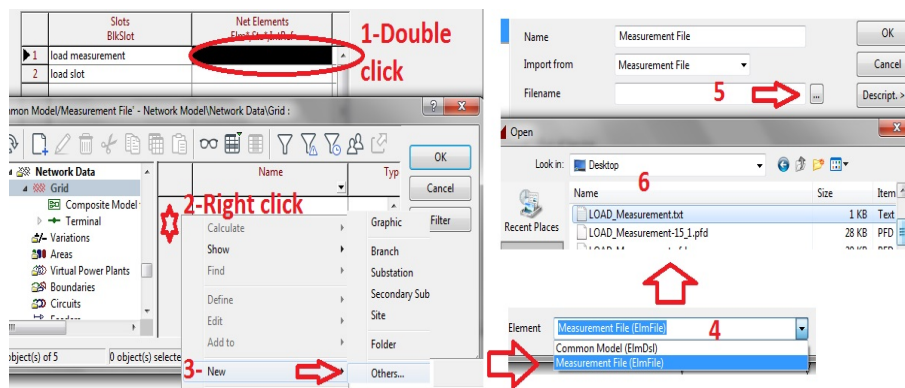


Fig. 26. Load "load measurement" file

8 – See Fig. 27.

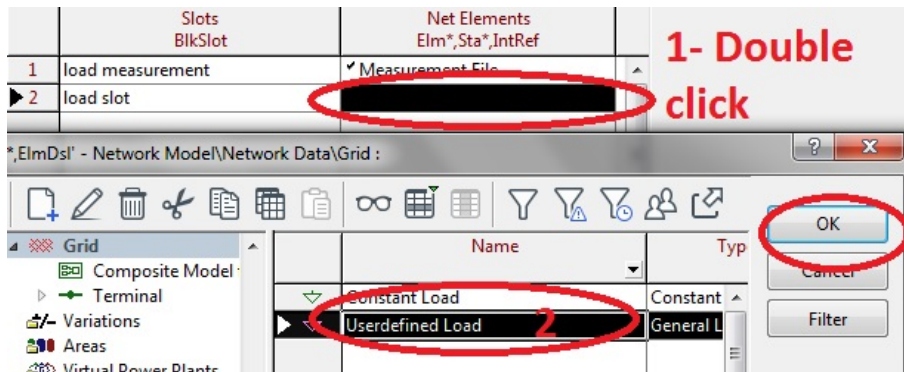


Fig. 27. See user define load

9 – See Fig. 28.

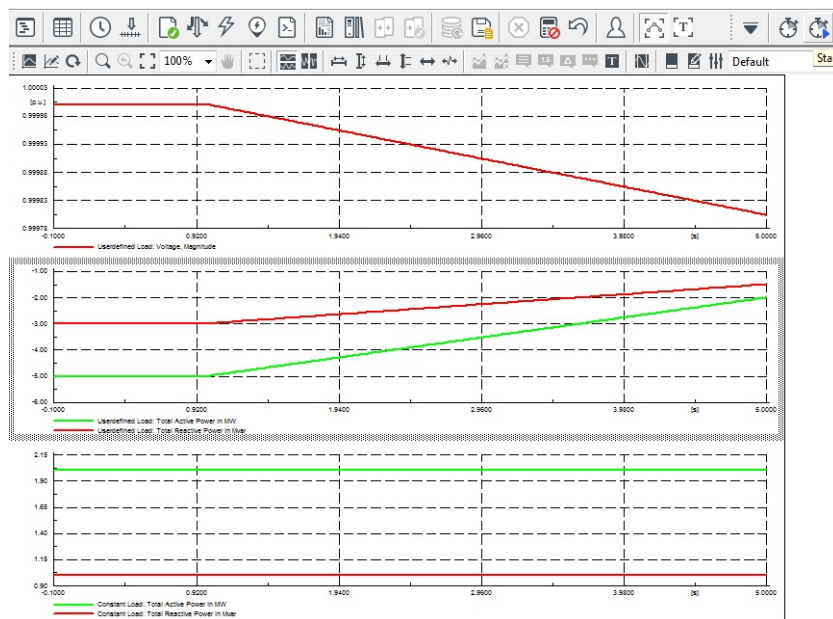


Fig. 28. See the output of the program

### 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.

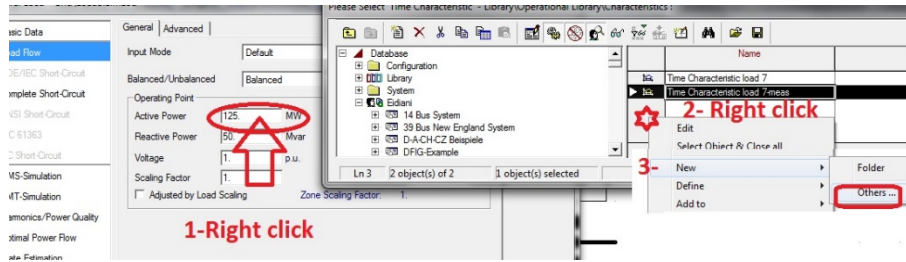


Fig. 29. See active power

2 – See Fig. 30.

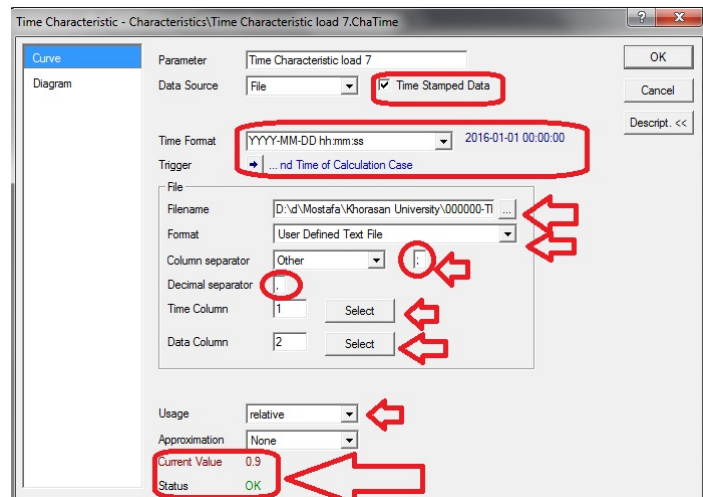


Fig. 30. See time characteristic

3 – See Fig. 31.

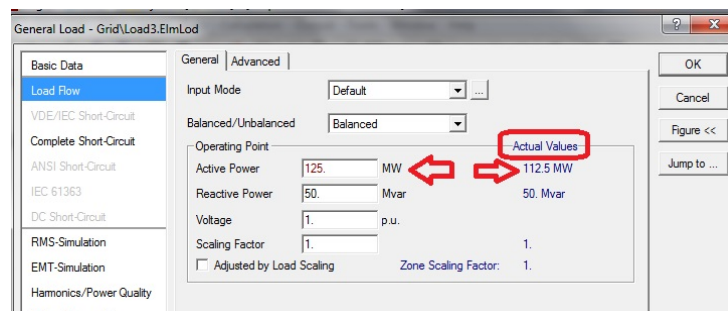


Fig. 31. See Active value

4 – See Fig. 32.

| Name  | Grid | Act. Pow. MW | Current Value MW | Minutes min                |
|-------|------|--------------|------------------|----------------------------|
| 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.

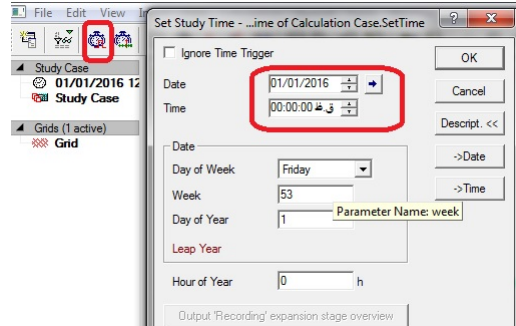


Fig. 33. See date and time

## 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.

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