

Simulando Redes Eléctricas Inteligentes com OpenDSS e Python

Paulo Radatz - paulo.radatz@gmail.com

Rodolfo Londero - rodolfopl@gmail.com

Ênio Viana - eniocc@gmail.com

10 de Julho de 2022





Conteúdo

- Instrutores
- Números do OpenDSS no Mundo e Brasil
- OpenDSS Visão Geral
- Controlando o OpenDSS usando Linguagem de Programação
- Demonstração
- Hands-on



Instrutores



Instrutor Paulo Radatz



Graduação Sanduíche:

- Engenharia Elétrica, Escola Politécnica da Universidade de São Paulo (USP-SP) (2010-2015)
- Politécnico de Milano – Milão, Itália (2012-2013)
- Melhor aluno de toda à escola de engenharia da USP-SP formado em 2015

Mestrado:

- Engenharia Elétrica, Escola Politécnica da Universidade de São Paulo (USP-SP) (2016-2019)
- Com tema: “Impacto das funções inteligentes de inversores de sistemas fotovoltaicos na operação de redes de distribuição de energia elétrica”

OpenDSS:

- Engenheiro / Cientista no Electric Power Research Institute (EPRI) – EUA
- 7 anos de experiência com o OpenDSS
- Criador do maior canal do YouTube sobre o OpenDSS do mundo: <https://www.youtube.com/PauloRadatz>
- Palestrante / Instrutor em diversos encontros, workshops e treinamentos sobre o OpenDSS. Incluindo o treinamento online do EPRI
- Desenvolvedor do OpenDSS
- Desenvolveu a primeira versão do SIGPerdas da Sinapsis
- Professor do curso de difusão “Análise de Sistemas Elétricos de Potência através do OpenDSS” fornecido pelo PECE da POLI-USP
- Professor no MBA em Redes de Distribuição de Energia Elétrica fornecido pelo PECE da POLI-USP
- Desenvolvedor do pacote Python py-dss-interface



Instrutor Rodolfo Londero



Graduação:

- Análise e Desenvolvimento de Sistemas, Instituto Federal Farroupilha-Alegrete/RS (2010-2013)
- Engenharia Elétrica, Universidade Federal do Pampa (Unipampa) Alegrete/RS (2015-2019)
 - Tema: Análise do transformador de estado sólido em substituição ao transformador convencional de redes de distribuição de energia para a conexão de sistemas de geração distribuída

Mestrado:

- Engenharia Elétrica, Universidade Federal de Santa Maria (USFM) (2019-2022)
 - Tema: “Metodologia para simulações de arcos elétricos aplicada ao estudo de energia incidente em sistemas elétricos de potência”

OpenDSS:

- Utiliza OpenDSS desde 2018
- Desenvolvedor do pacote Python py-dss-interface
- Programador desde 2013



Instrutor Ênio Viana



- **Bacharel** em Ciência da Computação
- **Especialização** em Perícia Forense Aplicada à Informática
- **Especialização** em Pós Graduação em Desenvolvimento de Aplicações em Dispositivos Móveis
- **Mestrado** em Engenharia Elétrica, Universidade Federal do Piauí (UFPI) (2017-2019)
 - Tema: “Heurística de Factibilização para Algoritmos Evolutivos na Reconfiguração de Redes em Sistemas de Distribuição de Energia Elétrica”
- **Doutorado** pausado em Ciência da Computação, Universidade Federal do Piauí (UFPI)
- Utiliza **OpenDSS** desde 2019; **Desenvolvedor** do pacote py-dss-interface
- Programador desde 2006
- Perito Criminal Oficial de TI - Perícia Forense do Estado do Ceará



Números do OpenDSS no Mundo e Brasil



Números do OpenDSS nos 100000 Downloads

TECHNOLOGY INNOVATION
EPRI STRATEGIC ENGAGEMENT

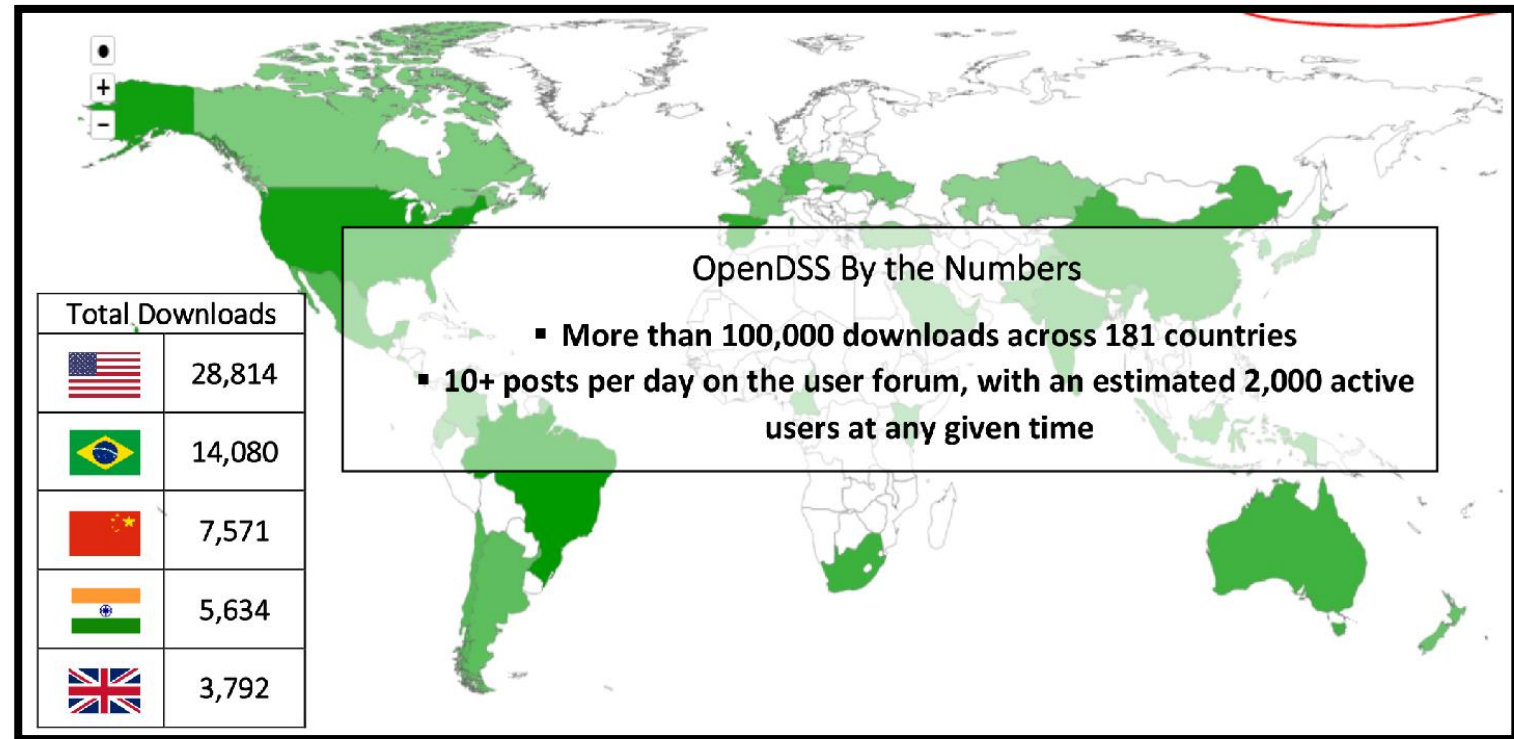
Unlocking Our Understanding of Distributed Energy Resources on the Power System: OpenDSS Hits 100,000 Downloads

Solving industry issues associated with advanced distribution planning is part of EPRI's public benefit mission. That's why it has continued to evolve the Distribution Simulator Software (DSS), initially developed by Roger Dugan and Tom McDermott in 1997 to determine the value (location and time) of distributed energy resources (DER) for distribution planning. No tool in the industry existed at the time to do this.

In 2008, DSS moved to open source (OpenDSS) expanding its use to utility engineers, researchers, and university students across the globe. Fast forward to today, and OpenDSS has reached a significant milestone with more than 100,000 downloads and a new graphical user interface (OpenDSSGUI, [1], [2]).

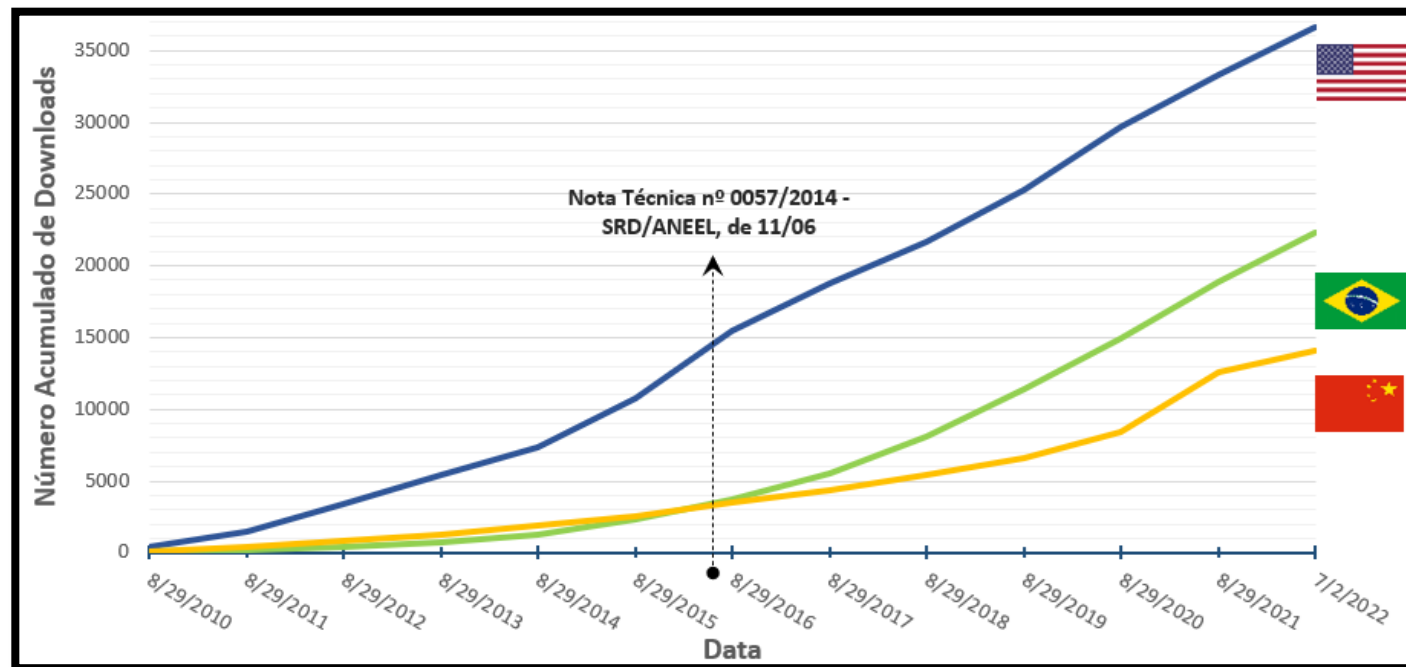
Figure 1: Illustration of OpenDSS Downloads




Link





Crescimento do uso do OpenDSS no Brasil



Total	
	36655
	22315
	14116

PRODIST Módulo 7

ANEEL – Motivos pela escolha do OpenDSS

OpenDSS no Brasil



OpenDSS Visão Geral



O que é o OpenDSS?

- **O que é**

- Software de simulação de circuitos elétricos no domínio da frequência (**fasorial**), baseado em **linhas de códigos**

- **O que não é**

- Não é um software de simulação de transitórios eletromagnéticos (domínio do tempo)

[Site oficial do OpenDSS](#)

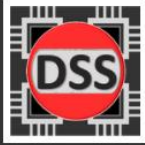
[Características Fundamentais do OpenDSS](#)



Download e Instalação

- [Version 9.4.0.6](#)


Home / Browse / Science & Engineering / Simulations / OpenDSS



OpenDSS

EPRI Distribution System Simulator
Brought to you by: [davismont](#), [rdugan](#), [robertkhenry](#), [temcdm](#), [wsunderm1](#)

★★★★★ 12 Reviews Downloads: 373 This Week Last Update: 3 days ago



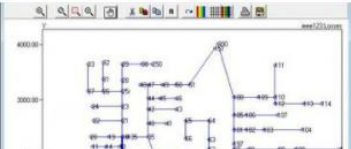
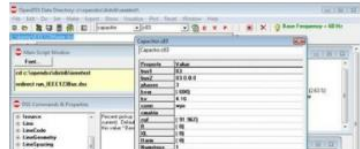
 [Download](#) [Get Updates](#) [Share This](#)

Windows

[Summary](#) [Files](#) [Reviews](#) [Support](#) [Wiki](#) [Feature Requests](#) [News](#) [Discussion](#) [Code](#)

The OpenDSS is an electric power Distribution System Simulator (DSS) for supporting distributed resource integration and grid modernization efforts. See Discussion Forum for latest news.

Project Samples





Fórum e Nosso grupo no Telegram

Fórum
Nosso grupo no
Telegram

The screenshot shows the SourceForge website for OpenDSS. The top navigation bar includes links for Open Source Software, Business Software, Services, and Resources. The OpenDSS project page is displayed, featuring the project logo and a list of contributors. The 'Discussion' tab is selected, showing a list of topics and their details.

Topic	Posts	Views	Last Post
"Wait" command slowing down the script considerably! By Mattia Secchi on Mon Dec 23, 2019 03:25 PM	4	26	By Mattia Secchi on Wed Jan 08, 2020 01:40 PM
Inverter models By Rakesh Belchandan on Fri Jan 03, 2020 06:07 PM	5	47	By Rakesh Belchandan on Tue Jan 07, 2020 09:02 PM
Split phase transformer By Rakesh Belchandan on Mon Oct 21, 2019 02:23 PM	2	37	By Rakesh Belchandan on Tue Jan 07, 2020 08:48 PM
kW rating of Generator using com interface in matlab. By Roger Dugan on Thu Jan 02, 2020 01:21 PM	5	47	By Roger Dugan on Thu Jan 02, 2020 01:21 PM



Recursos

- Pasta do OpenDSS: C:\Program Files\OpenDSS

Program Files > OpenDSS				
Name	Date modified	Type	Size	
Doc	1/8/2020 10:44 AM	File folder		
EPRITestCircuits	1/8/2020 10:44 AM	File folder		
Examples	1/8/2020 10:44 AM	File folder		
IEEETestCases	1/8/2020 10:44 AM	File folder		
Training	1/8/2020 10:44 AM	File folder		
x64	1/8/2020 10:44 AM	File folder		
x86	1/8/2020 10:44 AM	File folder		
License.txt	3/19/2019 11:56 AM	Text Document	2 KB	
readme.txt	10/11/2019 1:55 PM	Text Document	8 KB	



Controlando o OpenDSS usando Linguagem de Programação



Versões

1. OpenDSS.exe Standalone EXE
2. OpenDSSEngine.dll *In-process* COM server
3. OpenDSSDirect.dll Direct Call DLL
4. OpenDSSCmd.exe Standalone EXE sem interface

- Cada uma está disponível em 32 e 64-bit
- KLUSolve.dll, “sparse matrix solver”
- DSSView.exe, programa separado para processamento de saídas gráficas

C:\Program Files\OpenDSS\x64

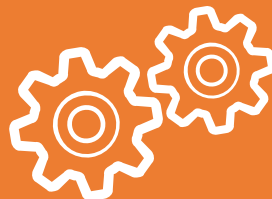
Name

- ComPorts.ini
- DSSProgress.exe
- DSSView.exe
- IndMach012a.dll
- KLUSolve.dll
- kmetis.exe
- OpenDSS.exe
- OpenDSS_COM.chm
- OpenDSScmd.exe
- OpenDSSDirect.dll
- OpenDSSDirect.h
- OpenDSSengine.dll
- pmetis.exe



Por que controlar o OpenDSS por meio de outras linguagens de programação?

**Implementar algoritmos
não presentes no
OpenDSS**



**Desenvolver novos
elementos**

**Automatizar tarefas
repetitivas e/ou manuais**



**Obter resultados
relevantes**



Quais linguagens de programação podem ser usadas?

- Excel VBA
- VB.net
- C#
- C/C++
- Delphi, Free Pascal
- MATLAB
- **Python**
- Java
- LabView
- R
- Fortran (for DLLs, with DirectDLL)
- Julia (with DirectDLL)

Oportunidade de usar a linguagem de sua preferência

Choose a Ranking: IEEE Spectrum | Trending

Language Types: Web, Enterprise, Mobile, Embedded

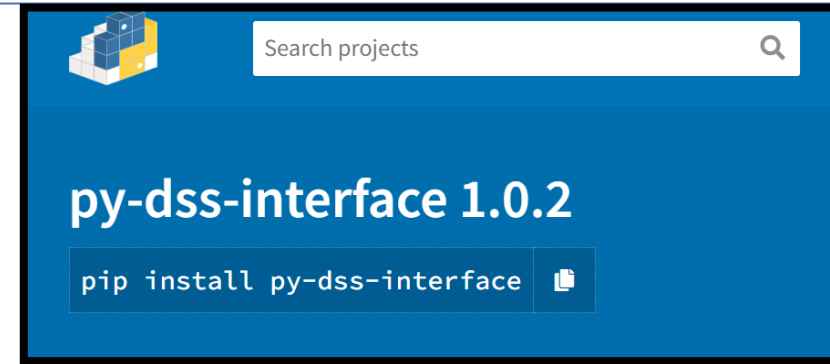
Language Ranking: IEEE Spectrum

Rank	Language	Type	Score
1	Python	Web, Enterprise, Mobile, Embedded	100.0
2	Java	Web, Enterprise, Mobile, Embedded	95.4
3	C	Enterprise, Mobile, Embedded	94.7
4	C++	Enterprise, Mobile, Embedded	92.4
5	JavaScript	Web	88.1
6	C#	Web, Enterprise, Mobile, Embedded	82.4
7	R	Enterprise	81.7
8	Go	Web, Enterprise	77.7
9	HTML	Web	75.4
10	Swift	Mobile, Embedded	70.4
11	Arduino	Embedded	68.4
12	Matlab	Enterprise	68.3



Python integration: py-dss-interface

- Pacote Python
- Usa a versão DirectDLL oficial do OpenDSS
 - OpenDSS Version 9.3.0.1 vem com o pacote
 - Usuário pode usar sua versão do OpenDSS
- Criado a partir do documento “Direct connection Shared Library (DLL) for OpenDSS” feito pelo Davis Montenegro
- Instalando do PyPI
 - ***pip install py-dss-interface***



<https://pepy.tech/project/py-dss-interface>

py-dss-interface

Summary

PyPI link	https://pypi.org/project/py-dss-interface
Total downloads	17,942
Total downloads - 30 days	512
Total downloads - 7 days	98

Examples



Demonstração



Conteúdo

- OpenDSS standalone
 - Abrir um alimentador
 - Rodar uma simulação estática
 - Obter resultados
 - Rodar uma simulação temporal
 - Obter resultados dos medidores e monitores
 - Demand Interval
- OpenDSS + Python
 - Criar o objeto dss
 - O método **text**
 - Lendo e escrevendo propriedades
 - Lendo resultados



Hands-on



Explicação do Hands-on

- O Hands-on é dividido em duas partes:
 - Simulação Estática
 - Simulação Temporal
- Responder usando OpenDSS e OpenDSS+Python:
 - Simulação Estática
 - Parte 3 (Não precisa F e G do item 4)
 - Simulação Temporal
 - Parte 3
 - Parte 4

Minicurso 1: Simulando Redes Elétricas Inteligentes com OpenDSS e Python
IX Simpósio Brasileiro de Sistemas Elétricos - 2022
Paulo Radatz, Rodolfo Londero e Enio Viana

Alimentador

O alimentador a ser utilizado nos exercícios é o circuito teste 123Bus, conforme Figura 1. Deve-se realizar o download do OpenDSS para ter acesso ao alimentador, que ficará disponível no seguinte diretório:

C:\Program Files\OpenDSS\IEEETestCases\123Bus

Deve-se utilizar o arquivo IEEE123Master.dss para resolver os exercícios apresentados a seguir.

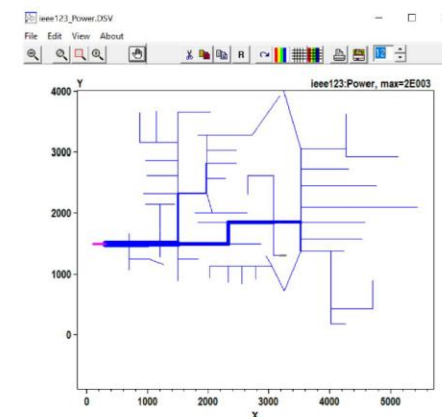


Figura 1: IEEE123Master



Dicas – Simulação Estática - Summary

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Source/Fault Vsource

Base Frequency = 60 Hz

C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.655 %)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

!REGULATORS - REDIRECT TO DEFINITIONS FILE
! This file contains definitions for the remainder of regulators on the feed
Redirect IEEE123Regulators.DSS
! SPOT LOADS -- REDIRECT INPUT STREAM TO LOAD DEFINITIONS FILE
Redirect IEEE123Loads.DSS
! All devices in the test feeder are now defined.
! Many of the voltages are reported in per unit, so it is important to establish a common base.
! We will let the DSS compute the voltage bases by doing a zero-load power flow.
! There are only two voltage bases in the problem: 4160V and 480V. These must be used consistently.
Set VoltageBases = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
CalcVoltageBases ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES
set mode=snap
solve

Summary Results

Memory: 21676K Circuit Status: SOLVED Total Iterations = 19, Control Iterations = 6, Max Solution Iterations = 4

```
import py_dss_interface
```

```
# Initialize
```

```
dss = py_dss_interface.DSSDLL()
```

```
# Define the file path
```

```
dss_file = r"C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\Exemplo_Python" \  
           r"\123Bus\IEEE123Master.dss"
```

```
# Compile
```

```
dss.text(f"compile [{dss_file}]")
```

```
# Solve
```

```
dss.text("set mode=snap")
```

```
dss.solution_solve()
```




Dicas – Simulação Estática – Perdas

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.65 %)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Memory: 34568K

Circuit Status: Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =

iee123_Losses.Txt - Bloco de notas

Arquivo	Editar	Formatar	Exibir	Ajuda
"Line.SW6"	0.00000,	0.0	-6.93889E-021	
"Line.SW7"	0.00000,	0.0	0	
"Line.SW8"	0.00000,	0.0	0	
"Transformer.XFM1"	0.00000,	0.0	0.000100046	
"Capacitor.C83"	0.00000,	0.0	-655.663	
"Capacitor.C88A"	0.00000,	0.0	-54.0696	
"Capacitor.C90B"	0.00000,	0.0	-54.1217	
"Capacitor.C92C"	0.00000,	0.0	-53.7647	
"Transformer.REG2A"	0.00000,	0.0	0.000227322	
"Transformer.REG3A"	0.00000,	0.0	0.000102683	
"Transformer.REG4A"	0.00002,	0.0	0.0169435	
"Transformer.REG3C"	0.00000,	0.0	9.96803E-005	
"Transformer.REG4B"	0.00001,	0.0	0.00870587	
"Transformer.REG4C"	0.00001,	0.0	0.0106501	
LINE LOSSES=		96.0 kW		
TRANSFORMER LOSSES=		0.0 kW		
TOTAL LOSSES=		96.0 kW		
TOTAL LOAD POWER =		3519.3 kW		
Percent Losses for Circuit =		2.73 %		

Ln 143, Col 37 100% Windows (CRLF) UTF-8

```
total_losses = dss.circuit_losses()
total_losses_active = total_losses[0]
total_losses_reactive = total_losses[1]

print("\nLosses")
print(f"Active Losses: {total_losses_active / 1000} kW")
print(f"Reactive Losses: {total_losses_reactive / 1000} kvar")
```



Dicas – Simulação Estática – Perdas

```
# Getting losses
total_losses = dss.circuit_losses()
total_losses_active = total_losses[0]
total_losses_reactive = total_losses[1]

print("\nLosses")
print(f"Active Losses: {total_losses_active / 1000} kW")
print(f"Reactive Losses: {total_losses_reactive / 1000} kvar")

# Getting Lines and Transformers losses
line_losses = dss.circuit_line_losses()
line_losses_active = line_losses[0]
line_losses_reactive = line_losses[1]

print("\nLine losses")
print(f"Line Active Losses: {line_losses_active} kW")
print(f"Line Reactive Losses: {line_losses_reactive} kvar")

transformer_losses = total_losses_active/1000 - line_losses_active
print("\nTransformer losses")
print(f"Transformer Active Losses: {transformer_losses} kW")
```



Dicas – Simulação Estática – Tensões

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.65%)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Memory: 34840K Circuit Status: ... Total Iterations = 19, Control Iterations = 6, Max Solution Iterations = ...

ieee123_VLN_Node.Txt - Bloco de notas

Arquivo Editar Formatar Exibir Ajuda

LINE-GROUND and LINE-LINE VOLTAGES BY BUS & NODE

Bus	Node	VLN (kV)	Angle	pu	Base kV	Node-Node
150	.... 1	2.4018 /_	0.0	0.99999	4.160	1-2
-	2	2.4018 /_	-120.0	0.99999	4.160	2-3
-	3	2.4018 /_	120.0	0.99999	4.160	3-1
150R	... 1	2.4918 /_	0.0	1.0375	4.160	1-2
-	2	2.4918 /_	-120.0	1.0375	4.160	2-3
-	3	2.4918 /_	120.0	1.0375	4.160	3-1
149	.... 1	2.4918 /_	0.0	1.0375	4.160	1-2
-	2	2.4918 /_	-120.0	1.0375	4.160	2-3
-	3	2.4918 /_	120.0	1.0375	4.160	3-1
1	..... 1	2.4617 /_	-0.6	1.025	4.160	1-2
-	2	2.4861 /_	-120.3	1.0351	4.160	2-3
-	3	2.4704 /_	119.6	1.0286	4.160	3-1
2	..... 2	2.4856 /_	-120.3	1.0349	4.160	
3	..... 3	2.4665 /_	119.6	1.0269	4.160	
7	..... 1	2.4393 /_	-1.1	1.0156	4.160	1-2
-	2	2.4821 /_	-120.6	1.0334	4.160	2-3

Bus 152

```
dss.circuit_set_active_bus("152")
```

```
voltages_nodes = dss.bus_vmag_angle()  
vmag1 = voltages_nodes[0]  
vmag2 = voltages_nodes[2]  
vmag3 = voltages_nodes[4]
```

```
voltages_nodes_pu = dss.bus_pu_vmag_angle()  
v1pu = voltages_nodes_pu[0]  
v2pu = voltages_nodes_pu[2]  
v3pu = voltages_nodes_pu[4]
```



Dicas – Simulação Estática – Correntes

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.65%)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Summary Results

Memory: 35224K Circuit Status: Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Base Frequency = 60 Hz

Currents Seq
Currents Elem
Currents Elem Resid

Phases=3 Bus1=98.1.2.3 Bus2=99.1.2.3 LineCode=3 Length=0.275
Phases=3 Bus1=99.1.2.3 Bus2=100.1.2.3 LineCode=3 Length=0.55
Phases=3 Bus1=100.1.2.3 Bus2=450.1.2.3 LineCode=3 Length=0.3
Phases=3 Bus1=197.1.2.3 Bus2=101.1.2.3 LineCode=3 Length=0.8
Phases=1 Bus1=101.3 Bus2=102.3 LineCode=11 Length=0.25
Phases=3 Bus1=101.1.2.3 Bus2=105.1.2.3 LineCode=3 Length=0.225
Phases=1 Bus1=102.3 Bus2=103.3 LineCode=11 Length=0.275
Phases=1 Bus1=103.3 Bus2=104.3 LineCode=11 Length=0.325
Phases=1 Bus1=105.2 Bus2=106.2 LineCode=10 Length=0.7
Phases=3 Bus1=105.1.2.3 Bus2=108.1.2.3 LineCode=3 Length=0.225
Phases=1 Bus1=106.2 Bus2=107.2 LineCode=10 Length=0.325
Phases=1 Bus1=108.1 Bus2=109.1 LineCode=9 Length=0.575
Phases=3 Bus1=108.1.2.3 Bus2=300.1.2.3 LineCode=3 Length=0.45
Phases=1 Bus1=109.1 Bus2=110.1 LineCode=9 Length=1
Phases=1 Bus1=110.1 Bus2=111.1 LineCode=9 Length=0.3
Phases=1 Bus1=110.1 Bus2=112.1 LineCode=9 Length=0.575
Phases=1 Bus1=112.1 Bus2=113.1 LineCode=9 Length=0.125
Phases=3 Bus1=113.1 Bus2=114.1 LineCode=9 Length=0.525
Phases=1 Bus1=135.1.2.3 Bus2=35.1.2.3 LineCode=9 Length=0.325
Phases=3 Bus1=152.1.2.3 Bus2=52.1.2.3 LineCode=4 Length=0.375
Phases=3 Bus1=160r.1.2.3 Bus2=67.1.2.3 LineCode=1 Length=0.4
Phases=3 Bus1=160r.1.2.3 Bus2=67.1.2.3 LineCode=6 Length=0.35

3Master.dss Run.dss

SS - C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

ieee123_Curr_Elem.Txt - Bloco de notas

Arquivo Editar Formatar Exibir Ajuda

CIRCUIT ELEMENT CURRENTS

(Currents into element from indicated bus)

Power Delivery Elements

Bus	Phase	Magnitude, A	Angle	(Real)	+j (Imag)
ELEMENT = "Vsource.SOURCE"					
150	1	655.12	/ - 158.4	= -609.25	+j 240.83
150	2	424.35	/ - 40.7	= -321.57	+j 276.9
150	3	522.24	/ - 78.4	= 104.61	+j -511.65

150	0	655.12	/ - 21.6	= 609.25	+j -240.83
150	0	424.35	/ - 139.3	= -321.57	+j -276.9
150	0	522.24	/ - 101.6	= -104.61	+j 511.65

ELEMENT = "Transformer.REG1A"					
150	1	655.12	/ - 21.6	= 609.25	+j -240.83
150	2	424.35	/ - 139.3	= -321.57	+j -276.9
150	3	522.24	/ - 101.6	= -104.61	+j 511.65
150	0	183.17	/ - 178.1	= -183.07	+j 6.0748

Ln 1, Col 1 100% Windows (CRLF) UTF-8

```
dss.circuit_set_active_element(dss.bus_line_list()[0])  
bus_currents = dss.cktelement_currents_mag_ang()[6][1::2]  
bus_active_power = dss.cktelement_powers()[6][0::2]  
bus_reactive_power = dss.cktelement_powers()[6][1::2]
```



Dicas – Simulação Estática – Potências

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Base Frequency = 60 Hz

Powers kVA
Powers MVA
Powers kVA Elem
Powers MVA Elem

LOAD DEFINITIONS FILE

Loads.DSS]

in the test feeder are now defined.

voltages are reported in per unit, so it is important to establish the base voltages
compare with the result with greater ease.
he DSS compute the voltage bases by doing a zero-load power flow.
y two voltage bases in the problem: 4160V and 480V. These must be expressed in kv

s = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
s ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES

nds.dat

Master.dss Run.dss

SS - C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

Memory: 35168K Circuit Status: Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =

ieee123_Power_elem_kVA.txt - Bloco de notas

Arquivo Editar Formatar Exibir Ajuda

CIRCUIT ELEMENT POWER FLOW

(Power Flow into element from indicated Bus)

Power Delivery Elements

Bus	Phase	kW	+j kvar	kVA	PF
ELEMENT = "Vsource.SOURCE"					
150	1	-1463.3 +j	-578.4	1573.4	0.9300
150	2	-962.1 +j	-336.3	1019.2	0.9440
150	3	-1189.9 +j	-396.8	1254.3	0.9486
TERMINAL TOTAL		-3615.2 +j	-1311.5	3845.8	0.9401
150	0	0.0 +j	0.0	0.0	1.0000
150	0	0.0 +j	0.0	0.0	1.0000
150	0	0.0 +j	0.0	0.0	1.0000
TERMINAL TOTAL		0.0 +j	0.0	0.0	1.0000
ELEMENT = "Transformer.REG1A"					
150	1	1463.3 +j	578.4	1573.4	0.9300
150	2	962.1 +j	336.3	1019.2	0.9440
150	3	1189.9 +j	396.8	1254.3	0.9486

Ln 1, Col 1 100% Windows (CRLF) UTF-8



Dicas – Simulação Estática – Potências

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode =STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.65%)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Summary Results

Memory: 35188K Circuit Status: Total Iterations = 19, Control Iterations = 6, Max Solution Iterations = 19

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Base Frequency = 60 Hz

aster.dss

ains definitions for the remainder of regulators on the feeder:

Regulators.DSS

REDIRECT INPUT STREAM TO LOAD DEFINITIONS FILE

Loads.DSS

in the test feeder are now defined.

voltages are reported in per unit, so it is important to establish the base voltages
compare with the result with greater ease.
he DSS compute the voltage bases by doing a zero-load power flow.
y two voltage bases in the problem: 4160V and 480V. These must be expressed in kv

s = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
s ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES

rds.dat

Master.dss Run.dss

DSS - C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

ieee123_Buses.Txt - Bloco de notas

Arquivo Editar Formatar Exibir Ajuda

BUSES AND NODES IN ACTIVE CIRCUIT: ieee123

Bus	Base kV	Coord (x, y)	Keep?
"150"	4.160	(100 , 1500)	No
"150r"	4.160	(100 , 1500)	No
"149"	4.160	(300 , 1500)	No
"1"	4.160	(700 , 1500)	No
"2"	4.160	(700 , 1675)	No
"3"	4.160	(700 , 1250)	No
"7"	4.160	(1000 , 1500)	No
"4"	4.160	(700 , 1050)	No
"5"	4.160	(1025 , 1250)	No
"6"	4.160	(1275 , 1150)	No
"8"	4.160	(1200 , 1500)	No
"12"	4.160	(1200 , 1275)	No
"9"	4.160	(1200 , 1725)	No
"13"	4.160	(1500 , 1500)	No
"9r"	4.160	(1200 , 1725)	No
"14"	4.160	(1200 , 2150)	No
"34"	4.160	(1500 , 1350)	No
"10"	4.160	(1500 , 1500)	No

Ln 1, Col 1 100% Windows (CRLF) UTF-8

```
bus_x = dss.bus_read_x()  
bus_y = dss.bus_read_y()
```



Dicas – Simulação Estática – Linha

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

PDelements Line L116 C V P

C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.655 %)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

! This file contains definitions for the remainder of regulators on the feeder:
Redirect IEEE123Regulators.DSS
! SPOT LOADS -- REDIRECT INPUT STREAM TO LOAD DEFINITIONS FILE
Redirect IEEE123Loads.DSS
! All devices in the test feeder are now defined.
! Many of the voltages are reported in per unit, so it is important to establish
! that we can compare with the result with greater ease.
! We will let the DSS compute the voltage bases by doing a zero-load power flow.
! There are only two voltage bases in the problem: 4160V and 480V. These must be
Set VoltageBases = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
CalcVoltageBases ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES
BusCoord BusCoords.dat
set mode=snap
solve

Main IEEE123Master.dss Run.dss

Messages OpenDSS - C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE

Summary Results

Memory: 35692K Circuit Status: SOLVED Total Iterations = 19, Control Iterations = 6, Max

```
# Line L116
dss.lines_write_name("L116")
bus1 = dss.lines_read_bus1()
bus2 = dss.lines_read_bus2()
linecode = dss.lines_read_linecode()

rmatrix = dss.lines_read_rmatrix()
xmatrix = dss.lines_read_xmatrix()
cmatrix = dss.lines_read_cmatrix()

dss.circuit_set_active_bus(bus1.split(".")[0])
bus1_voltage_nodes = dss.bus_vmag_angle()[::2]

dss.circuit_set_active_bus(bus2.split(".")[0])
bus2_voltage_nodes = dss.bus_vmag_angle()[::2]

dss.circuit_set_active_element("Line.L116")
line_currents = dss.cktelement_currents_mag_ang()[6][::2]
line_active_power = dss.cktelement_powers()[6][::2]
line_reactive_power = dss.cktelement_powers()[6][1::2]

voltages_terminal_1 = dss.cktelement_voltages_mag_ang()[::2][3:]
voltages_terminal_2 = dss.cktelement_voltages_mag_ang()[::2][3:]
```



Dicas – Simulação Estática – Taps

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Summary
Voltages
Currents
Powers
Buses
BusFlow...
Converged
Elements
Elements in Class
Energy Meters
Event Log
Generators
Isolated
Losses
kV Base Mismatch
Line Constants ...
Loops
Mismatch
Taps
Monitor [monitor]
Zone [meter]
Zone [meter] Treeview
List ...

Results for Actor ID # 1
CPU selected: -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 237
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.65%)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Summary Results

Memory: 35556K Circuit Status: SOLVED Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =

```
dss.regcontrols_first()
for _ in range(dss.regcontrols_count()):
    print(f"{dss.regcontrols_read_name()} with tap
    number = {dss.regcontrols_read_tap_number()}")
    dss.regcontrols_next()
```




Dicas – Simulação Estática – Perfil de Tensão

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

PDelements

Circuit Plots
Monitor
Loadshapes
Profile
TCC Curves
Interpolate
Options...

Results for Actor ID # 1
CPU selected : -1
Status = SOLVED
Solution Mode = Snap
Number = 1
Load Mult = 1.000
Devices = 238
Buses = 132
Nodes = 278
Control Mode = STATIC
Total Iterations = 19
Control Iterations = 6
Max Sol Iter = 4

- Circuit Summary -
Year = 0
Hour = 0
Max pu. voltage = 1.05
Min pu. voltage = 0.97921
Total Active Power: 3.61524 MW
Total Reactive Power: 1.31151 Mvar
Total Active Losses: 0.0959769 MW, (2.655 %)
Total Reactive Losses: 0.192504 Mvar
Frequency = 60 Hz
Mode = Snap
Control Mode = STATIC
Load Model = PowerFlow

Redirect IEEE123Loads.DSS

! All devices in the test feeder are now defined.
!
! Many of the voltages are reported in per unit, so it is important to establish the base voltages
! that we can compare with the result with greater ease.
! We will let the DSS compute the voltage bases by doing a zero-load power flow.
! There are only two voltage bases in the problem: 4160V and 480V. These must be expressed in kv

Set VoltageBases = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
CalcVoltageBases ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES

BusCoord BusCoords.dat

New Energymeter.Fonte element=Transformer.regia terminal=1

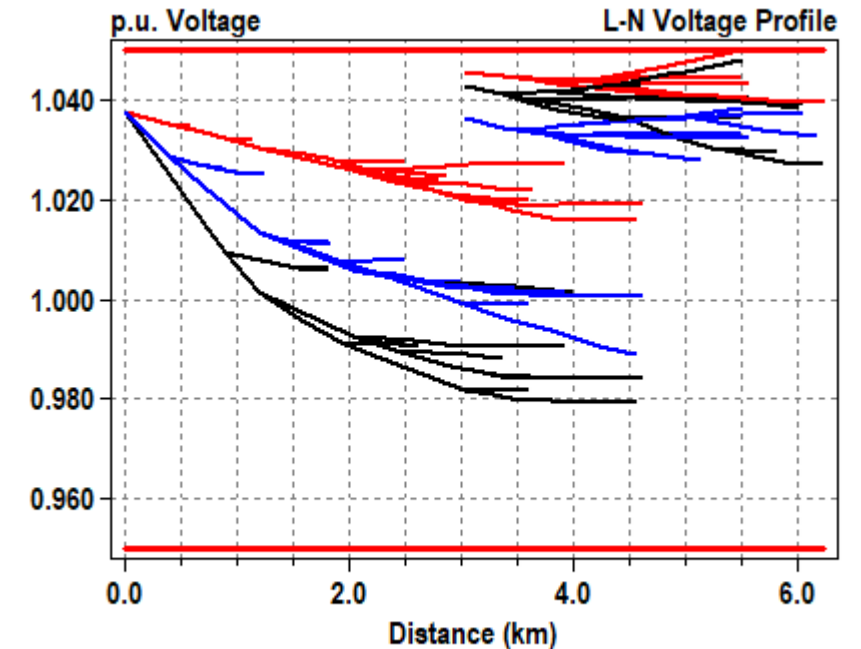
set mode=snap
solve

Main IEEE123Master.dss Run.dss

Messages OpenDSS - C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\IEEE123Master.dss

Summary Results

Memory: 35980K Circuit Status: SOLVED Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =





Dicas – Simulação Estática – Mapas

OpenDSS Data Directory: C:\Users\Rodolfo\Documents\OpenDSS\SBSE_2022\123Bus\

File Edit Do Set Make Export Show Visualize Plot Reset Help

Meters

Circuit Plots

- Monitor
- Loadshapes
- Profile
- TCC Curves
- Interpolate
- Options...

Autoadd Log

Circuit Plot

Daisy Plot

General Bus Data

General Line Data

Zone [meter]

Zone

Results for Actor ID # 1

CPU selected : -1

Status = SOLVED

Solution Mode = Snap

Number = 1

Load Mult = 1.000

Devices = 238

Buses = 132

Nodes = 278

Control Mode = STATIC

Total Iterations = 19

Control Iterations = 6

Max Sol Iter = 4

- Circuit Summary -

Year = 0

Hour = 0

Max pu. voltage = 1.05

Min pu. voltage = 0.97921

Total Active Power: 3.61524 MW

Total Reactive Power: 1.31151 Mvar

Total Active Losses: 0.0959769 MW, (2.655 %)

Total Reactive Losses: 0.192504 Mvar

Frequency = 60 Hz

Mode = Snap

Control Mode = STATIC

Load Model = PowerFlow

Summary Results

Memory: 36728K

Circuit Status: SOLVED

Total Iterations = 19, Control Iterations = 6, Max Solution Iterations =

```
Set VoltageBases = [4.16, 0.48] ! ARRAY OF VOLTAGES IN KV
CalcVoltageBases ! PERFORMS ZERO LOAD POWER FLOW TO ESTIMATE VOLTAGE BASES

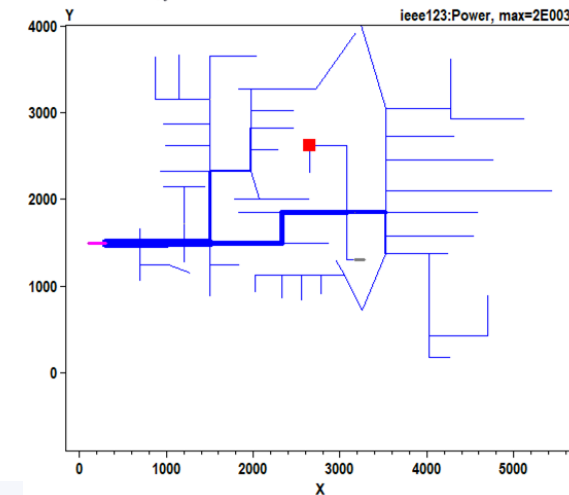
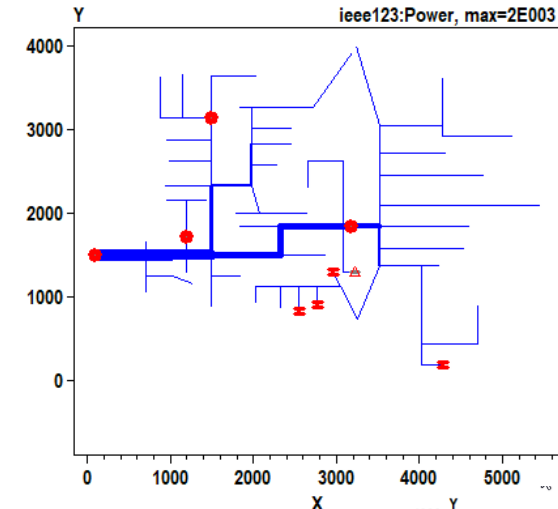
BusCoord BusCoords.dat

New Energymeter.Fonte element=Transformer.regia terminal=1

set markTransformers=yes
set markRegulators=yes
set markCapacitors=yes

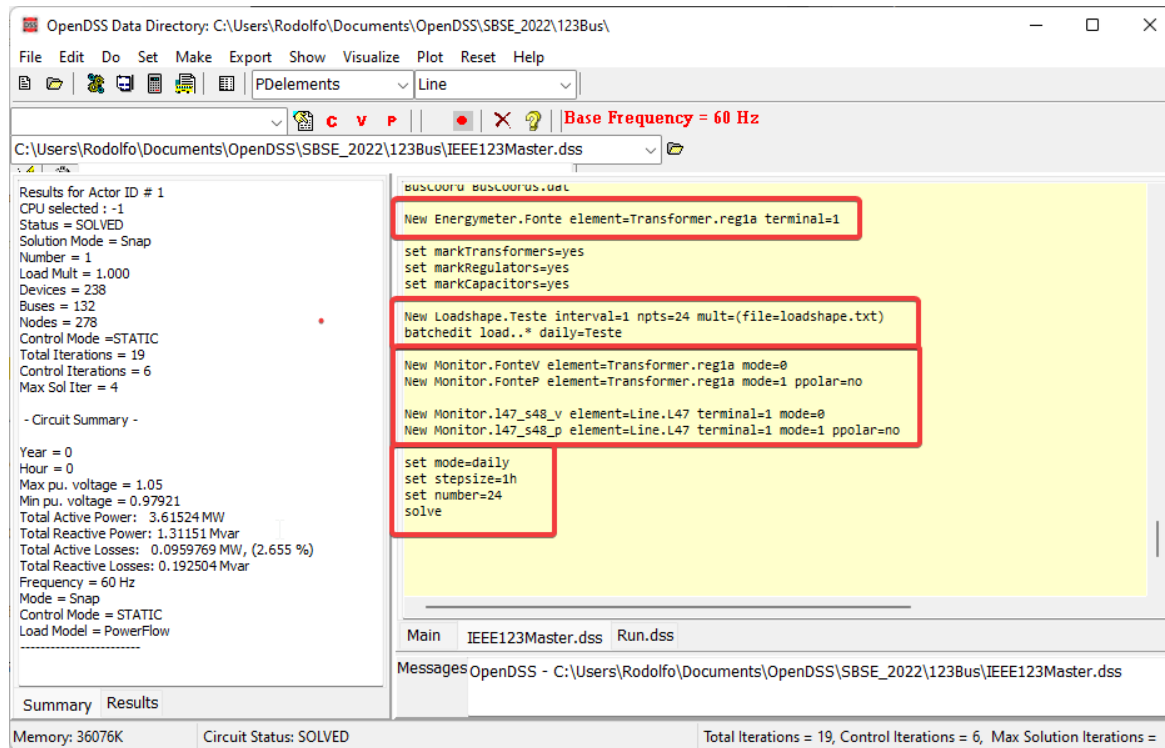
set mode=snap
solve

Set normvminpu=1.02
Set emergvminpu=1.0
plot circuit voltage dots=y labels=n
```





Dicas – Simulação Temporal



```
import py_dss_interface
import pathlib

script_path = os.path.dirname(os.path.abspath(__file__))

dss_file = pathlib.Path(script_path).joinpath("../feeders", "123Bus",
"IEEE123Master.dss")

dss = py_dss_interface.DSSDLL()

dss.text(f"compile [{dss_file}]")

dss.text("New Loadshape.my_loadshape interval=1 npts=24
mult=(file=loadshape.txt)")

dss.text(f"batchedit load.* daily=my_loadshape")

dss.text("set mode=daily")
dss.solution_solve()
```



Dicas – Simulação Temporal - Energia

Criar:

- EnergyMeter
- Monitors

OpenDSS

[Show](#) meters

Python

```
dss.meters_write_name("Feeder")
register_names = dss.meters_register_names()
register_values = dss.meters_register_values()
```

```
ieee123_EMout.Txt - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda

ENERGY METER VALUES

Registers:
Reg 1 = kWh
Reg 2 = kvarh
Reg 3 = Max kW
Reg 4 = Max kVA
Reg 5 = Zone kWh
Reg 6 = Zone kvarh
Reg 7 = Zone Max kW
Reg 8 = Zone Max kVA
Reg 9 = Overload kWh Normal
Reg 10 = Overload kWh Emerg
Reg 11 = Load EEN
Reg 12 = Load UE
Reg 13 = Zone Losses kWh
Reg 14 = Zone Losses kvarh
Reg 15 = Zone Max kW Losses
Reg 16 = Zone Max kvar Losses
Reg 17 = Load Losses kWh
Reg 18 = Load Losses kvarh
Reg 19 = No Load Losses kWh
```

```
ieee123_EMout.Txt - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda

Reg 50 = Aux13
Reg 51 = Aux18
Reg 52 = Aux23
Reg 53 = Aux28
Reg 54 = 4.16 kV No Load Loss
Reg 55 = Aux4
Reg 56 = Aux9
Reg 57 = Aux14
Reg 58 = Aux19
Reg 59 = Aux24
Reg 60 = Aux29
Reg 61 = 4.16 kV Load Energy
Reg 62 = Aux5
Reg 63 = Aux10
Reg 64 = Aux15
Reg 65 = Aux20
Reg 66 = Aux25
Reg 67 = Aux30

Meter
Reg 1    Reg 2    Reg 3    Reg 4    Reg 5
fonte    48834    8663    3613    3845    47964
```



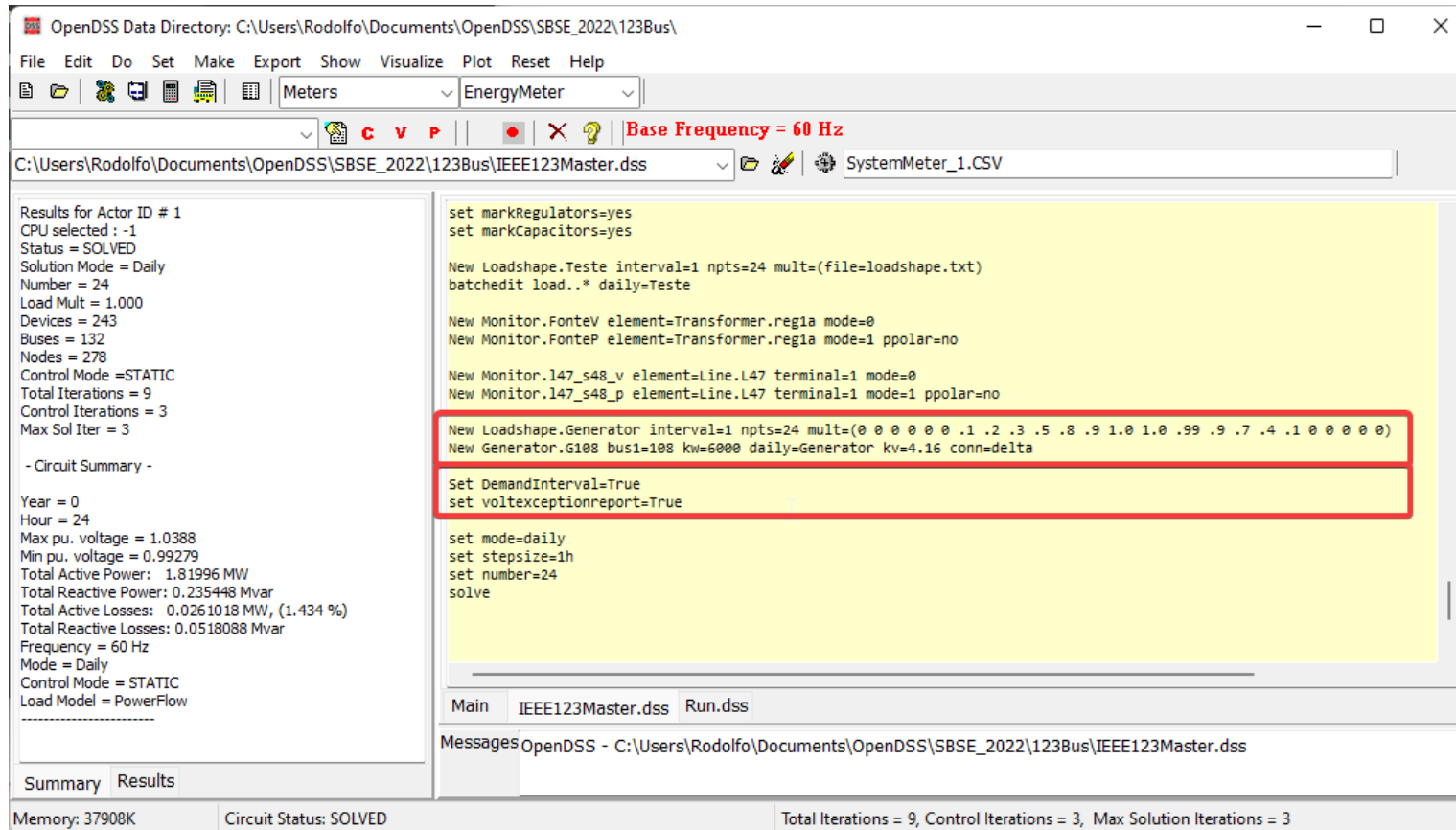
Dicas – Simulação Temporal – Plot

The screenshot displays the OpenDSS Data Directory window with the following components:

- Menu Bar:** File, Edit, Do, Set, Make, Export, Show, Visualize, Plot, Reset, Help.
- Toolbar:** Includes icons for file operations and simulation controls.
- Left Panel (PDelements):** Lists circuit elements and provides a 'C V P' (Circuit, Voltage, Power) view selector.
- Results for Actor ID # 1:**
 - CPU selected : -1
 - Status = SOLVED
 - Solution Mode = Daily
 - Number = 24
 - Load Mult = 1.000
 - Devices = 242
 - Buses = 132
 - Nodes = 278
 - Control Mode = STATIC
 - Total Iterations = 9
 - Control Iterations = 3
 - Max Sol Iter = 3
- Circuit Summary -:**
 - Year = 0
 - Hour = 24
 - Max pu. voltage = 1.0388
 - Min pu. voltage = 0.99279
 - Total Active Power: 1.81996 MW
 - Total Reactive Power: 0.235448 Mvar
 - Total Active Losses: 0.0261018 MW, (1.434 %)
 - Total Reactive Losses: 0.0518088 Mvar
 - Frequency = 60 Hz
 - Mode = Daily
 - Control Mode = STATIC
 - Load Model = PowerFlow
- Monitor Menu:** Circuit Plots, Monitor (selected), Loadshapes, Profile, TCC Curves, Interpolate, Options...
- Select Monitor Dialog:** A list box showing available monitors: fontev, fontev, fontev, l47_s48_v, l47_s48_p. The 'fontev' entry is selected.
- Select Channel(s) Dialog:** A list box titled 'Select One or More Columns From CSV File' containing:
 1. P1 (kW)
 2. Q1 (kvar)
 3. P2 (kW)
 4. Q2 (kvar)
 5. P3 (kW)
 6. Q3 (kvar)
 7. P4 (kW)
 8. Q4 (kvar)
- Bottom Panel:** Includes tabs for Main, IEEE123Master.dss, and Run.dss, a Messages window, and status information: Memory: 36108K, Circuit Status: SOLVED, Total Iterations = 9, Control Iterations = 3, Max Solution Iterations = 9.



Dicas – Simulação Temporal – Sobreensões



OpenDSS

```
edit generator.G108 pf=-valor
```

Python

```
dss.generators_write_pf(-valor)
```