

OpenDSS Training Workshop

Basics and Scripting

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EPRI Knoxville, TN

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Instructor



Andres Ovalle

Andres Ovalle is an Engineer/Scientist III with the Power System Studies team at the Electric Power Research Institute (EPRI). His current research activities focus on modeling of power systems, system protection in distribution and transmission, and impacts geomagnetic disturbance related harmonics on power systems. Mr. Ovalle joined EPRI in 2018. Prior to joining EPRI, Mr. Ovalle was with the French National Railways Company (SNCF) and the Grenoble Electrical Engineering Laboratory (G2E-lab) for approximately 2 years where he worked as a postdoctoral research engineer in the use of energy storage for the support of electrified railways. Mr. Ovalle received the B.S.E.E. degree from the Universidad de Los Andes, Bogota, Colombia, in 2011, the M.E.E. degree from the Universidad de Los Andes in 2013, and the Ph.D. in Electrical Engineering from the Université de Grenoble Alpes, Grenoble, France, in 2016.

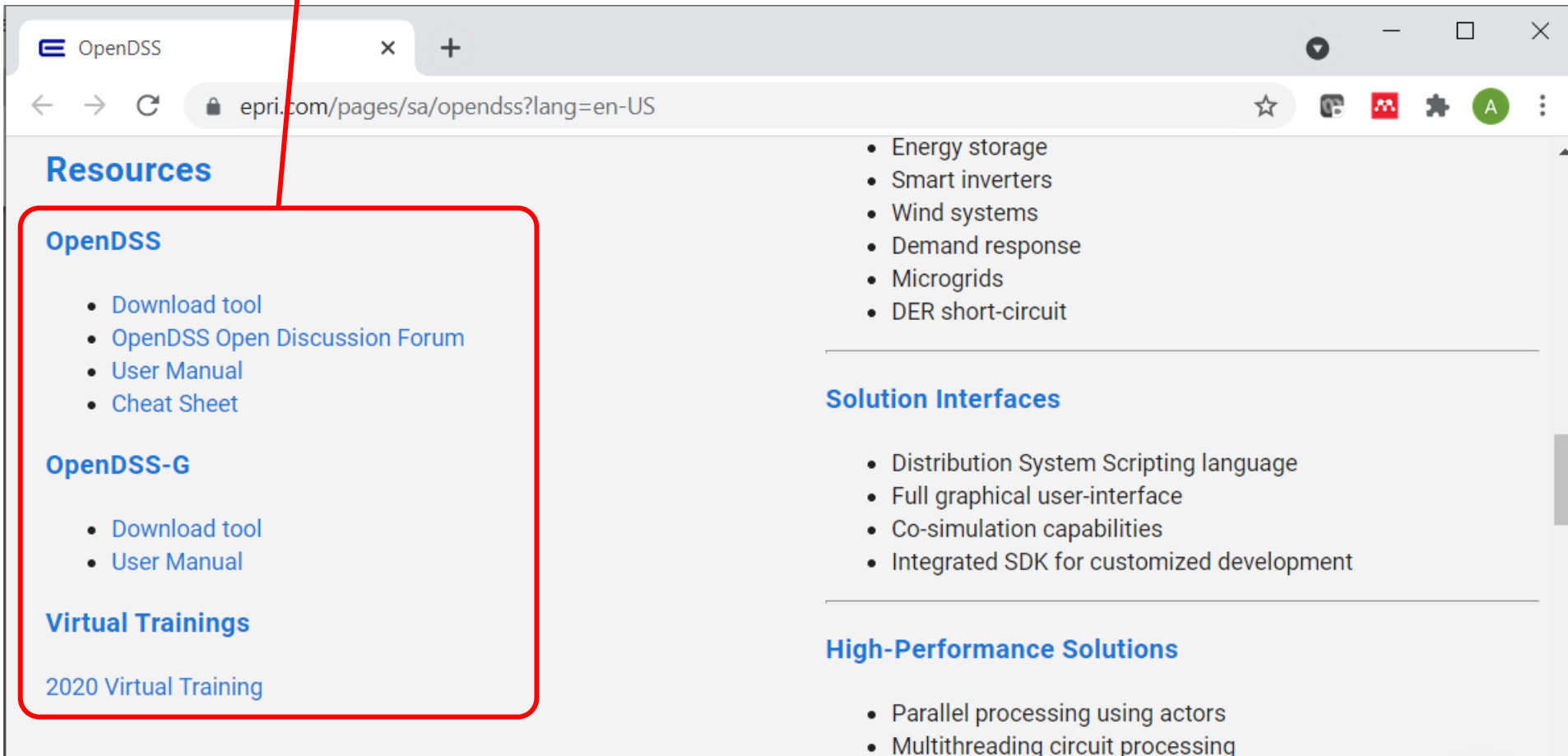


Installation and Startup

OpenDSS in EPRI.com

Plenty of resources to start with at EPRI.com

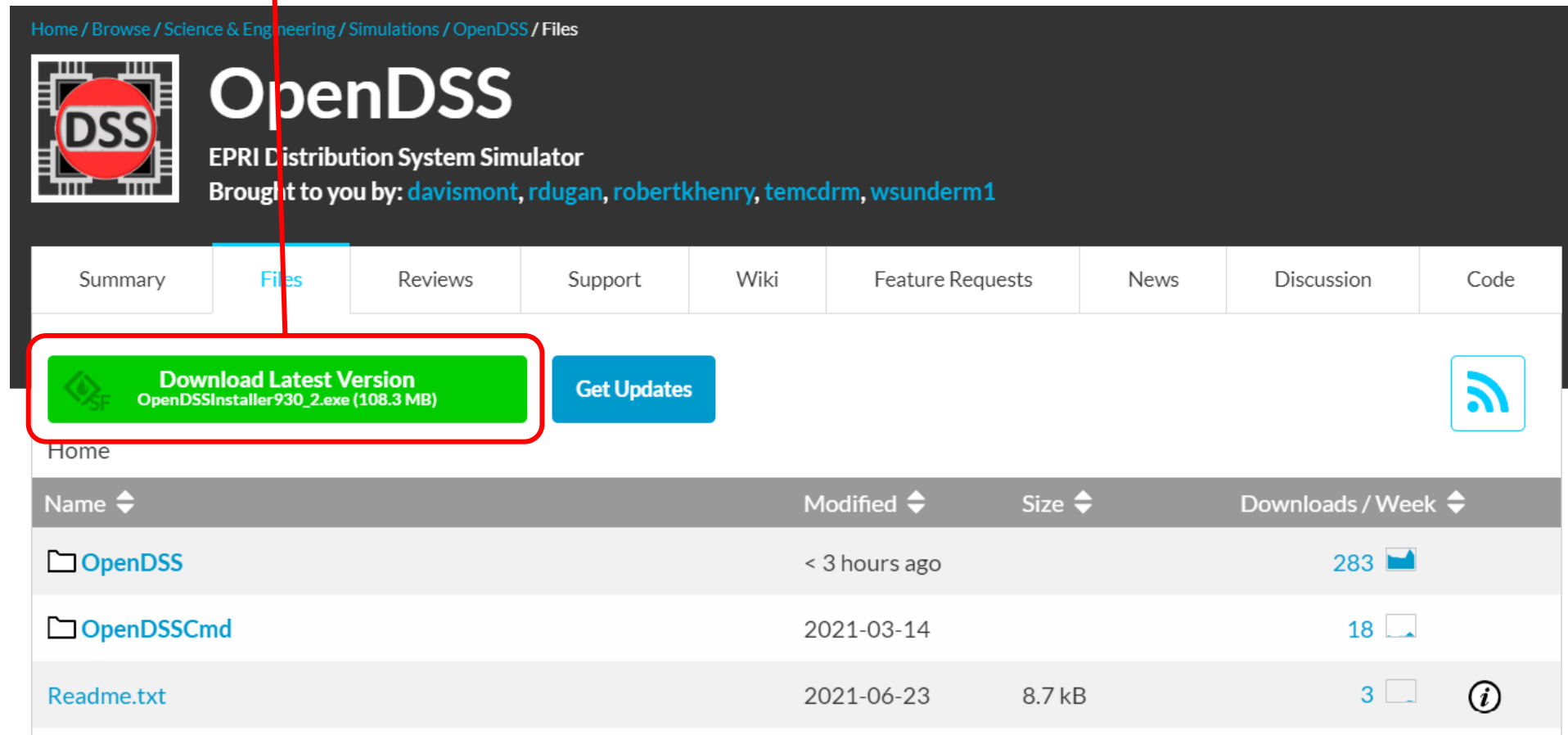
<https://www.epri.com/pages/sa/opendss?lang=en-US>



OpenDSS in SourceForge.net

You can get the latest installer of OpenDSS from

<https://sourceforge.net/projects/electricdss/files/>




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OpenDSS

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







Summary **Files** Reviews Support Wiki Feature Requests News Discussion Code

 **Download Latest Version**
OpenDSSInstaller930_2.exe (108.3 MB)

[Get Updates](#)



Home

Name	Modified	Size	Downloads / Week
 OpenDSS	< 3 hours ago		283 
 OpenDSSCmd	2021-03-14		18 
Readme.txt	2021-06-23	8.7 kB	3  

OpenDSS in SourceForge.net

The *News* and forums in the *Discussion* tab are one of the best resources to get your questions answered

The screenshot shows the OpenDSS project page on SourceForge. A red box highlights the 'Forums' section on the left sidebar, which includes links to 'Open Discussion (1800)', 'Help (1299)', 'Beginners (1046)', 'Experts (45)', and 'Help'. Another red box highlights the 'Discussion' and 'News' tabs at the top right of the main content area. Red arrows point from the text above to these two tabs. The main content area displays a list of forum topics under the 'Open Discussion' tab, including 'Flicker measurement using Monitors', 'distribution system (IEEE9 SYSTEM)', 'DD transformer RX', and 'Bug/inconsistency in Lines.R1 and Lines.X1 (vs. Lines.R0 and Lines.X0)'. The bottom of the page shows a table with columns for 'Size' and 'Downloads / Week'.


Size	Downloads / Week
283	18
8.7 kB	3

OpenDSS in SourceForge.net

In the *Code* tab you can get the URL of the main repository or download a snapshot of the source code

<https://svn.code.sf.net/p/electricdss/code/trunk>

Home / Browse / Science & Engineering / Simulations / OpenDSS / Files



OpenDSS

EPRI Distribution System Simulator

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

Tree [\[r3176\]](#) /

Download

HTTPS

svn://

HTTPS access

svn checkout <https://svn.code.sf.net/p/electricdss/code/trunk> electricdss-code

File	Date	Author	Commit
branches	2012-02-27	temcdm	[r666] for development branches
tags	2012-02-27	temcdm	[r667] for release snapshots

Discussion

Code

Downloads / Week

283

18

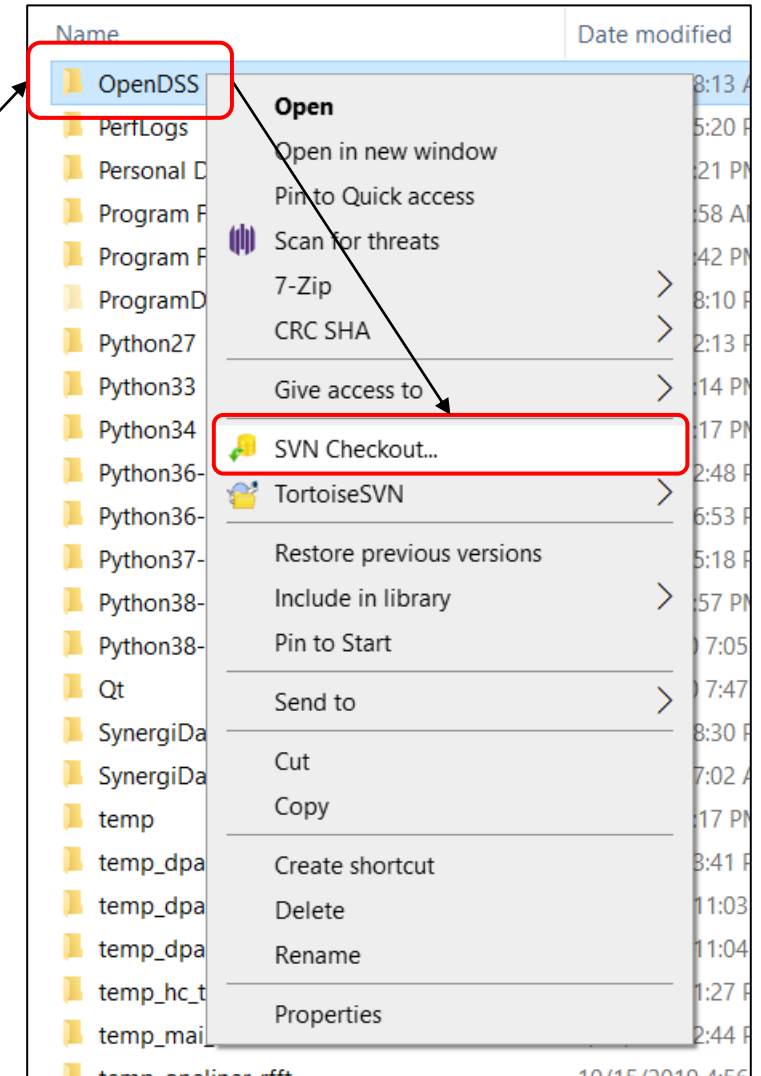
3

Accessing the Source Code Repository with TortoiseSVN

- Install a **TortoiseSVN** client from <https://tortoisesvn.net/downloads.html>
- Grab the OpenDSS files from SourceForge:

1. Create a clean directory such as **C: \OpenDSS**
2. Right-click on it and choose SVN Checkout... from the menu
3. The repository URL is <https://svn.code.sf.net/p/electricdss/code/trunk>

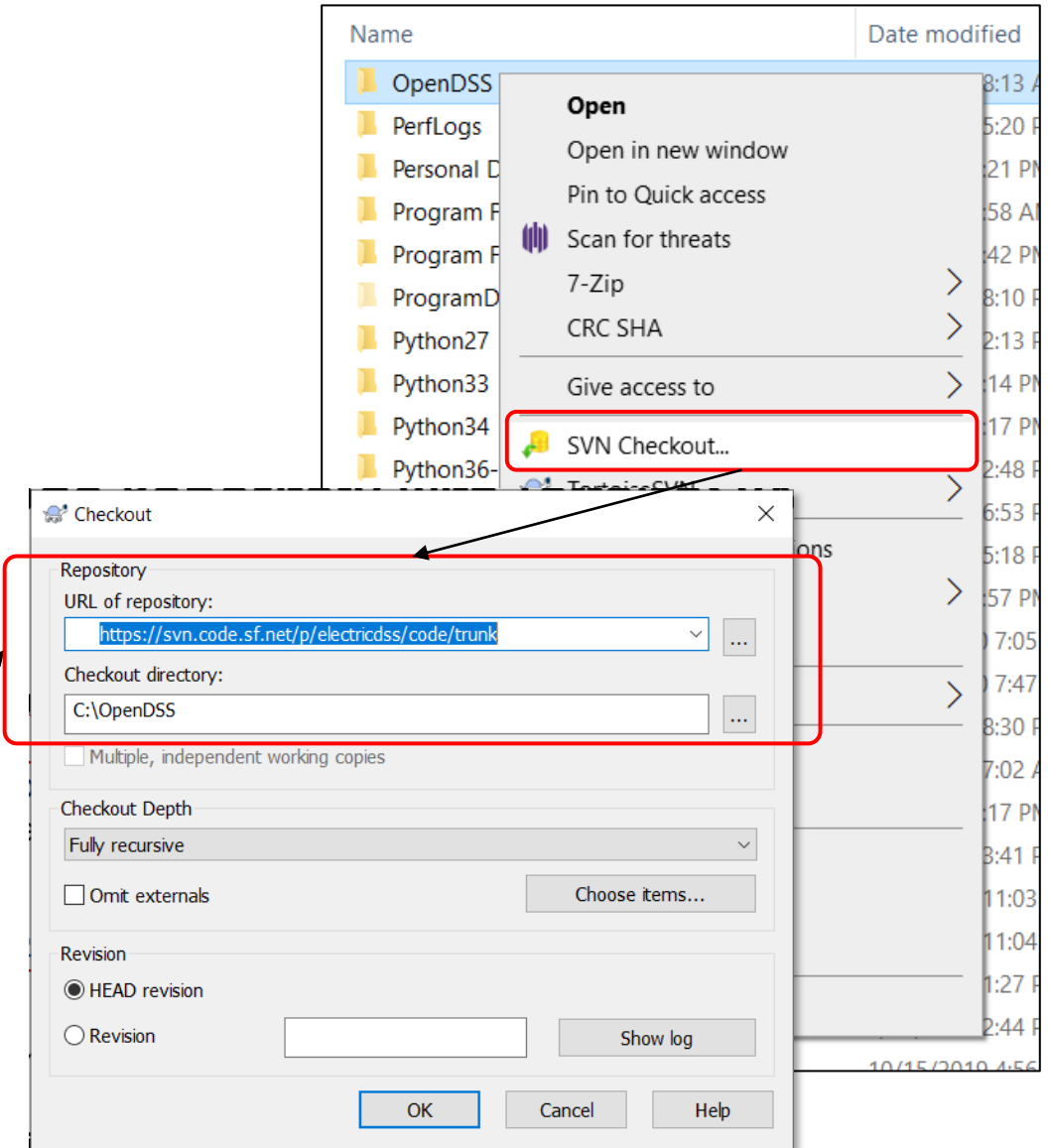
Thereafter, to update a folder or file, right-click on the folder or file and select **SVN Update**



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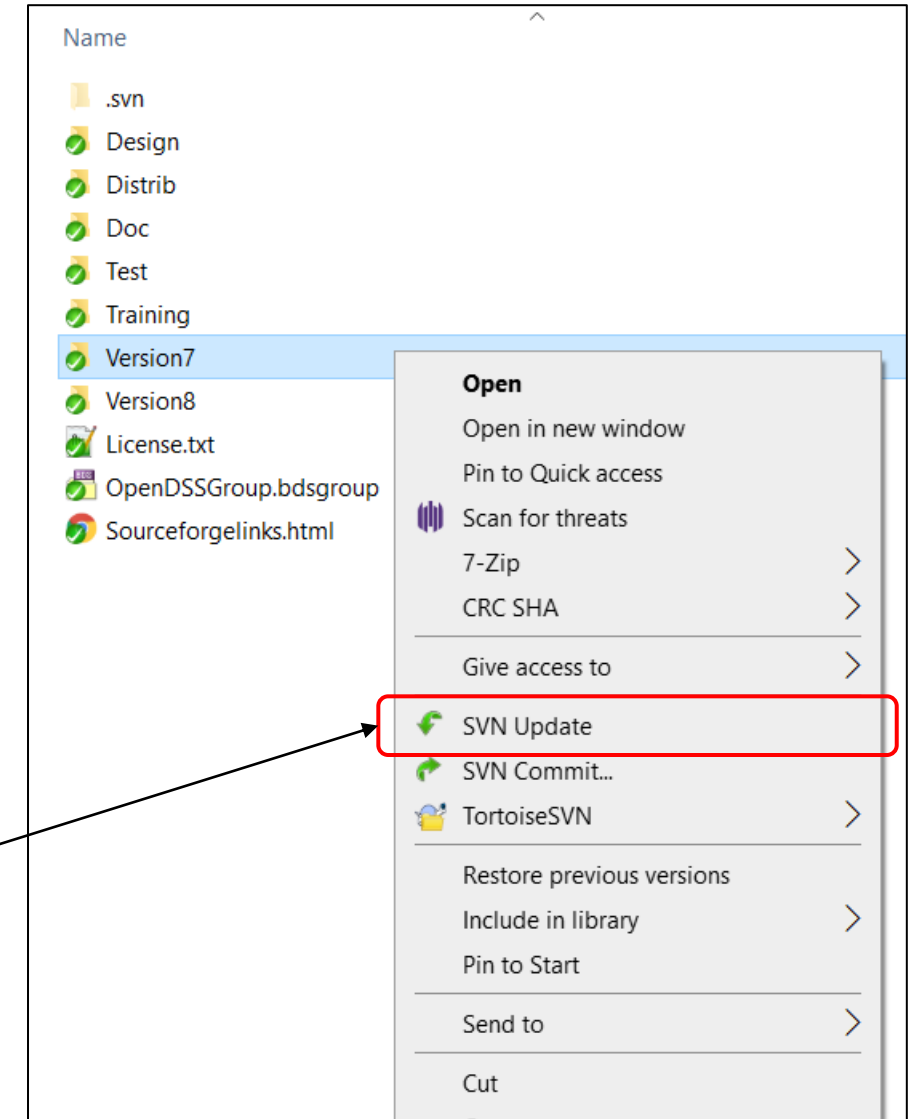
Thereafter, to update a folder or file, right-click on the folder or file and select **SVN Update**



Accessing the Source Code Repository with TortoiseSVN

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Thereafter, to update a folder or file, right-click on the folder or file and select **SVN Update**



OpenDSS Files in Installation folder

Explorer - C:\Program Files\OpenDSS\

- OpenDSS
 - Doc
 - EPRITestCircuits
 - ckt24
 - ckt5
 - ckt7
 - epri_dpv
 - Examples
 - IEEEETestCases
 - 123Bus
 - 13Bus
 - 34Bus
 - 37Bus
 - 4Bus-DY-Bal
 - 4Bus-GrdYD-Bal
 - 4Bus-OYOD-Bal
 - 4Bus-OYOD-UnBal
 - 4Bus-YD-Bal
 - 4Bus-YY-Bal
 - 4wire-Delta
 - 8500-Node
 - DG_Protection
 - IEEE 30 Bus
 - LineCodes
 - LVTestCase
 - LVTestCaseNorthAmerican
 - NEVTestCase
 - ShortCircuitCases
 - Training
 - x64
 - x86

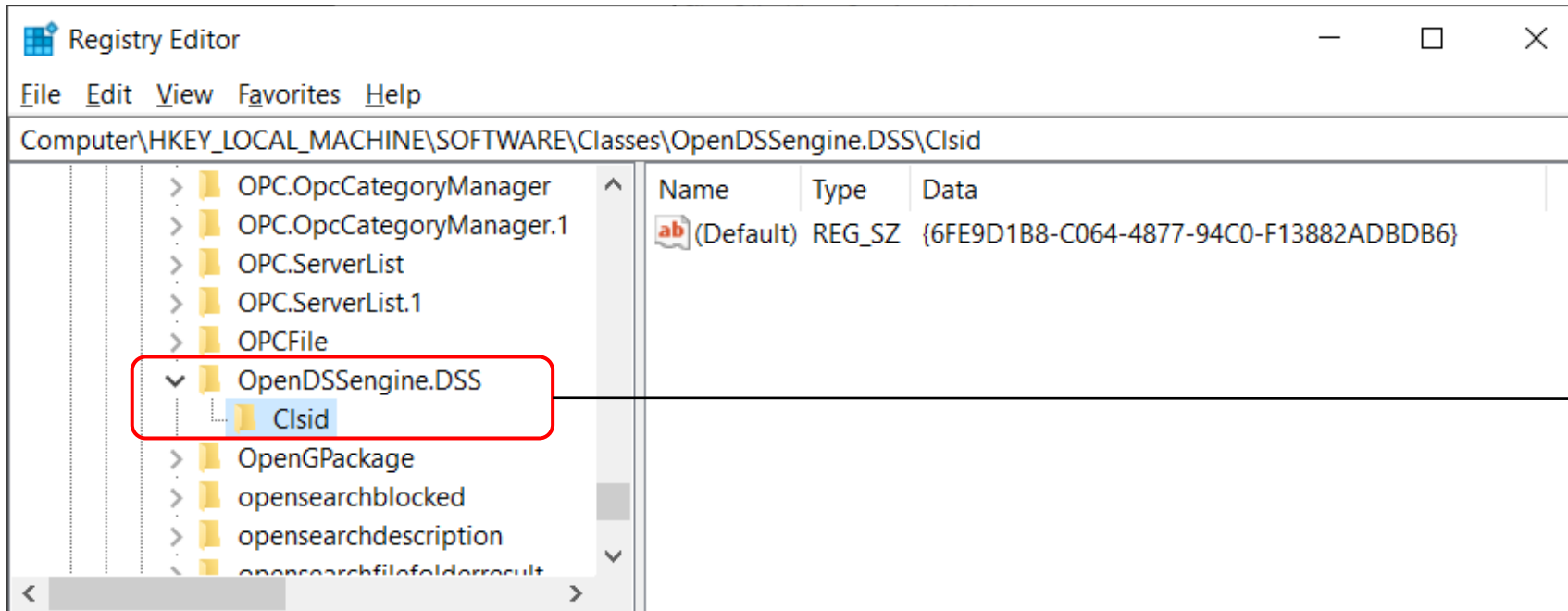
- Examples
 - C_Sharp
 - Celso_Example
 - civilar model
 - Excel
 - FreqScan
 - GICExample
 - HarmonicsTMode
 - InductionMachine
 - InverterModels
 - InverterTechNote
 - Loadshapes
 - Manual
 - Matlab
 - MemoryMappingLoadShapes
 - Microgrid
 - Parallel_Processing
 - Paulo_Example
 - Python
 - Scripts
 - Stevenson
 - StoCtrl_Current_PeakShave
 - StoCtrl_SeasonTarget
 - StorageControllerTechNote
 - StorageTechNote
 - SyntaxFiles
 - UPFC_Test
 - VB
 - VCCS
 - WampServer
- IEEEETestCases

Main OpenDSS program files

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

COM Server Registration

The installer automatically registers the OpenDSS COM server in the Windows Registry Entry



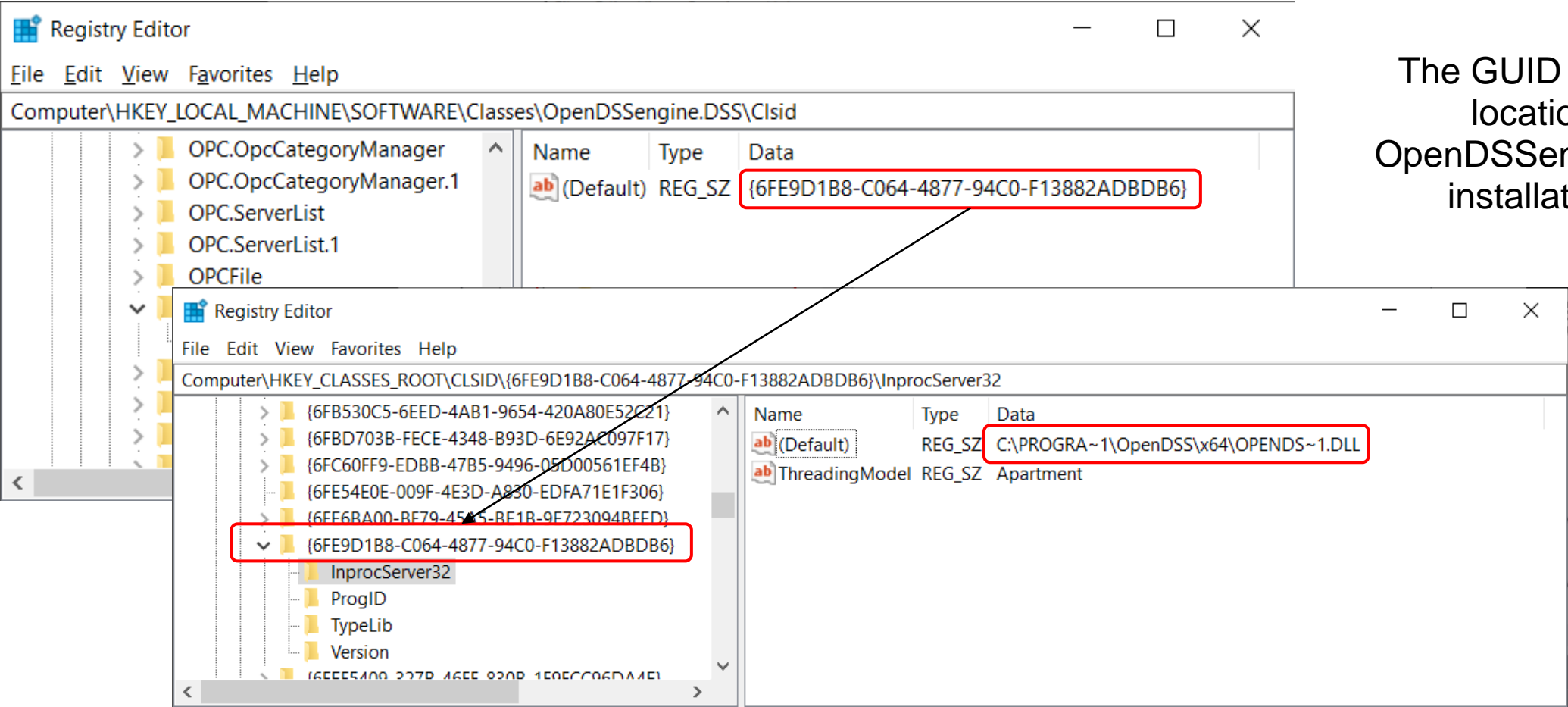
The COM Server shows up as OpenDSSEngine.DSS in the **Windows Registry**



The OpenDSS COM server is now available to any COM client/program on the computer

COM Server Registration

The installer automatically registers the OpenDSS COM server in the Windows Registry Entry



The GUID points to the location of the OpenDSSEngine.dll in the installation folder



Scripting Basics and Examples

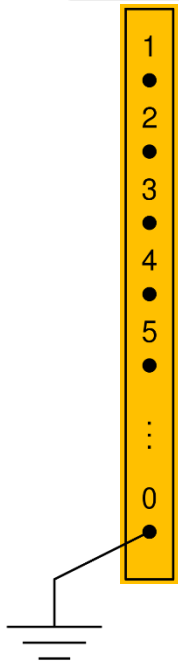
OpenDSS Buses and Nodes



Buses are a collection of 1 or more nodes

Bus Name

Bus_A



- A bus can host several nodes
- Node 0 of the bus is always grounded (0 V)
- Conventionally nodes 1 2 and 3 are associated to phases A B and C (but it is not mandatory)

Bus1=Bus_A.1.2.3.0

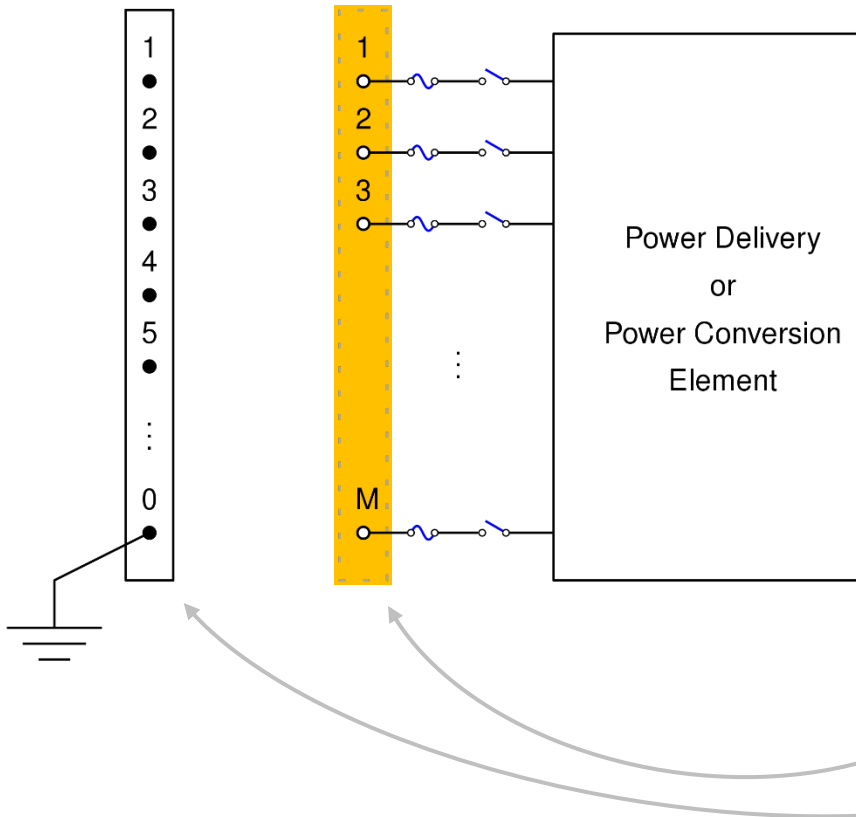
Assumed by default for 3-ph elements if not specified

OpenDSS Terminals



A Terminal can be associated to only one Bus.
A Bus can be associated to multiple terminals

Bus_A Terminal X

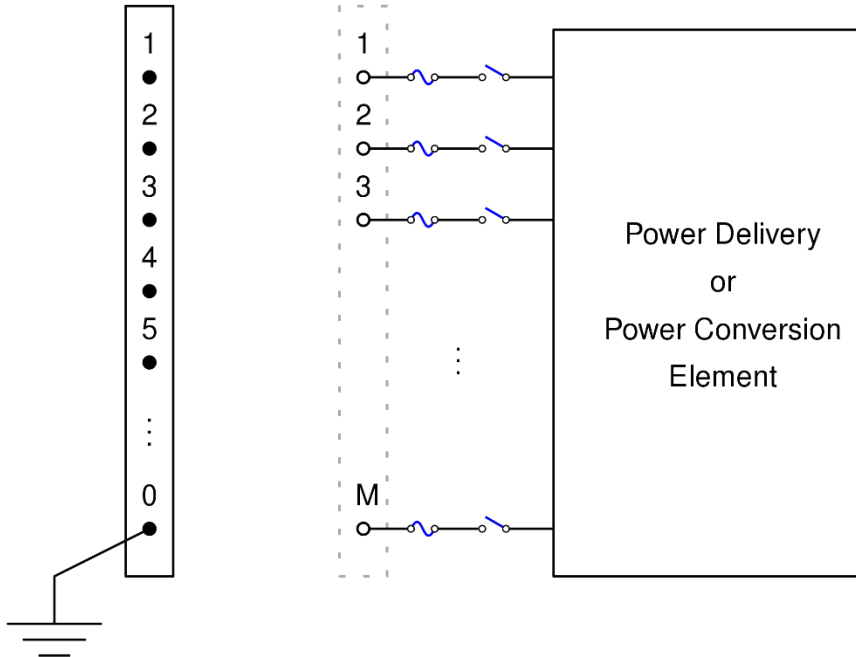


- Circuit Elements can have one or more terminals
- A Terminal is a collection of M conductors
- Circuit Elements have fuses in series with switches on each conductor of each of its terminals

Power Delivery (PDE) & Power Conversion (PCE) Elements

Vsources, Isource, Load, Generator, Storage, ...

Bus_A Terminal X



Transformers, Lines, Capacitors, Reactors,...

Term. 1

1

2

3

M

⋮

Power Conversion
Element

Term. 2

1

2

3

M

⋮

Term. 1

1

2

3

M

⋮

Power Delivery
Element

Term. 2

1

2

3

M

⋮

Term. 3

1

2

3

⋮

M

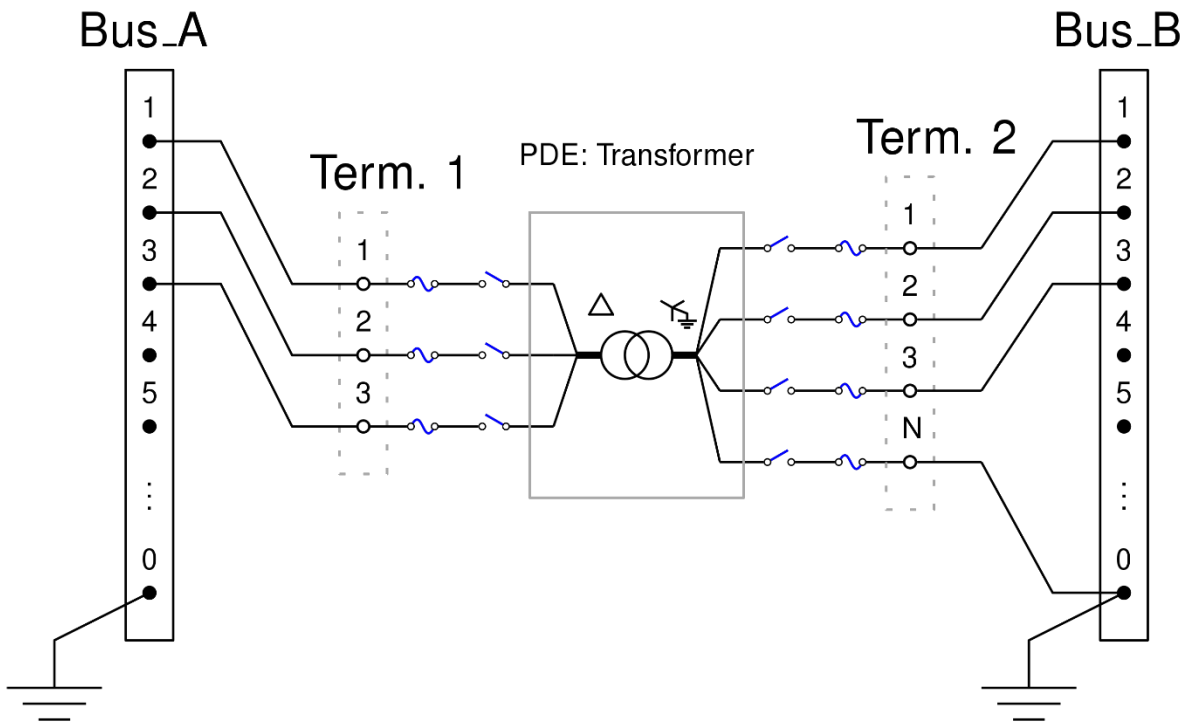
- Typically, one terminal but not always
- Connected in *shunt* with PDEs
- Function of V
- May be nonlinear

- Typically, two or more terminals
- Described by a Y_{prim} matrix

Example: Solidly Grounded Transformer

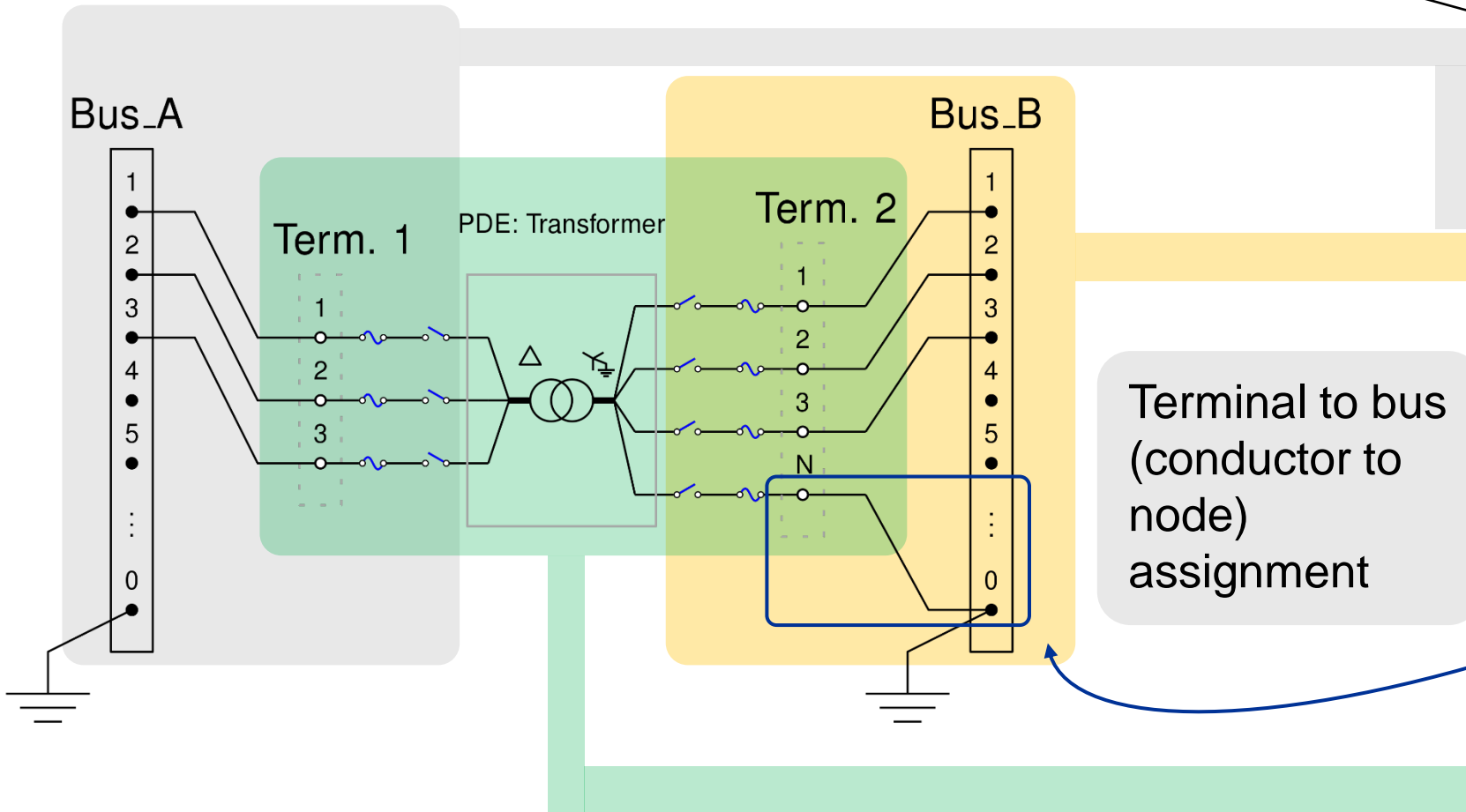
Part of the OpenDSS script that defines this transformer

```
/*  
My first DSS transformer  
*/  
  
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.0  
~ conns=[delta, wye]  
...
```



Example: Solidly Grounded Transformer

Circuit Element instantiation



```
/*  
My first DSS transformer  
*/  
  
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.0  
~ conns=[delta, wye]  
...
```

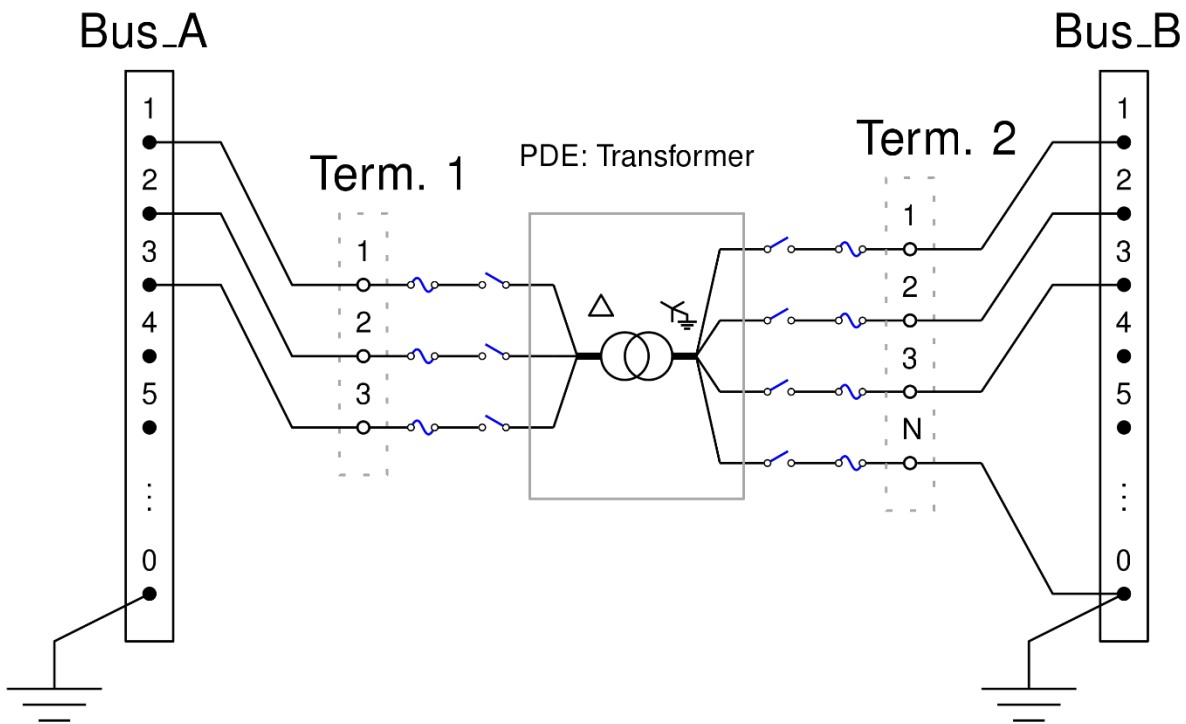
Terminal to bus
(conductor to
node)
assignment

Example: Solidly Grounded Transformer

Use `/*...*/`, `//` or `!` for line or block comments

```
/*  
My first DSS transformer  
*/
```

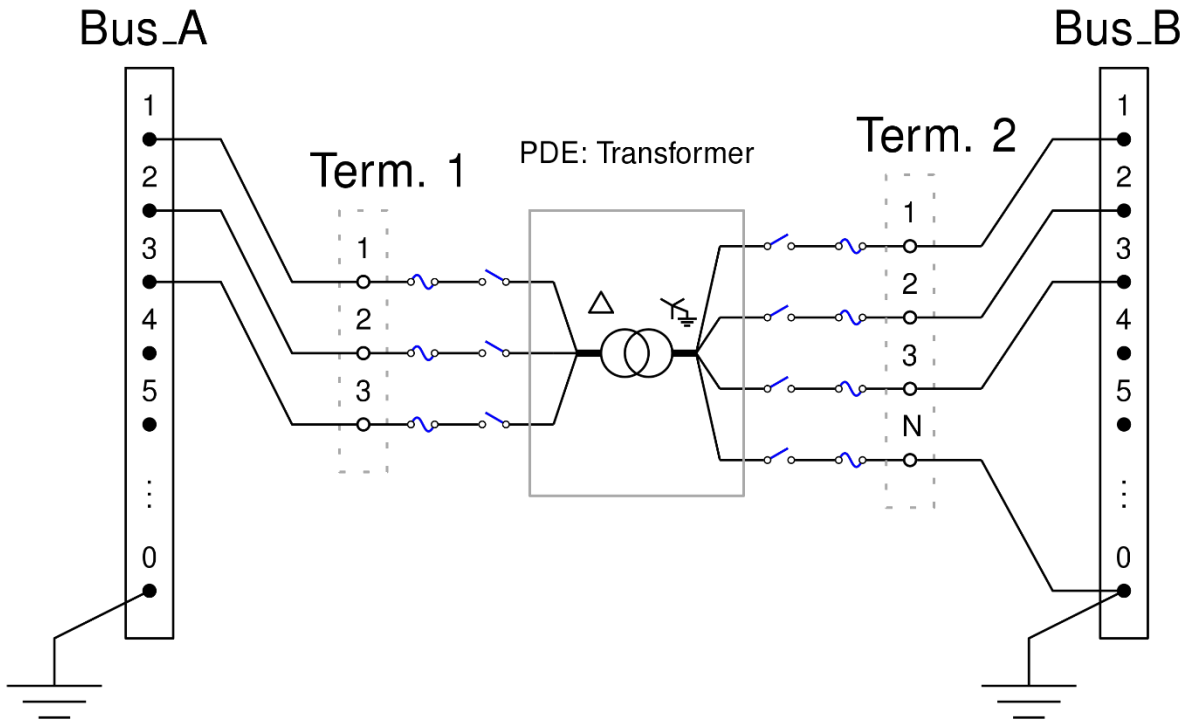
```
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.0  
~ conns=[delta, wye]  
...
```



Example: Solidly Grounded Transformer

Command syntax: **command** param_1, param_2 param_3

Comma, space or tab separated



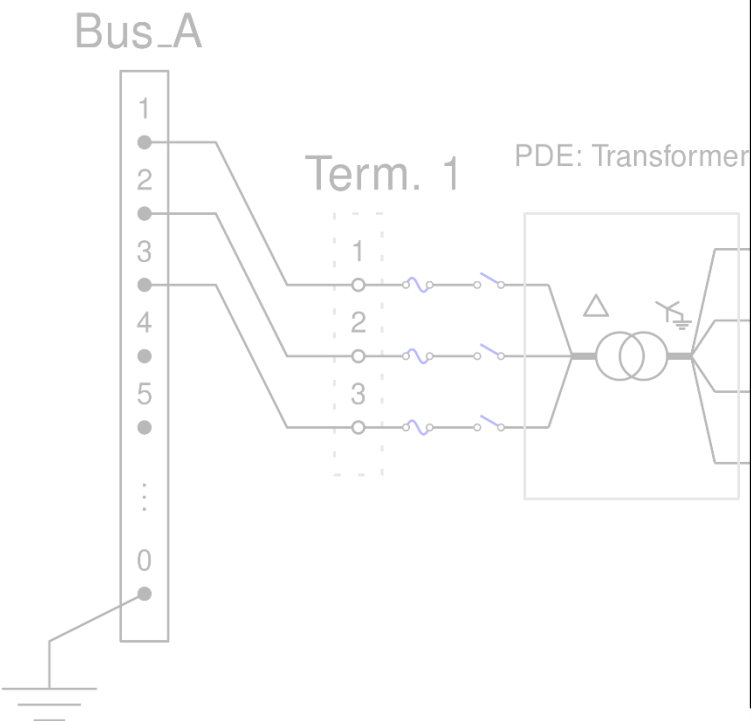
Use = to
separate
keywords from
values

```
/*  
My first DSS transformer  
*/  
  
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.0  
~ conns=[delta, wye]  
...
```

Example: Solidly Grounded Transformer

Command syntax: **command** param_1, param_2 param_3

Comma, space or tab separator



DSS Commands & Properties

Transformer

(1) phases

(2) windings

(3) wdg

(4) bus

(5) conn

(6) kV

(7) kVA

(8) tap

(9) %R

(10) Rneut

(11) Xneut

(12) buses

(13) conns

(14) kVs

(15) kVAs

(16) taps

(17) XHL

(18) XHT

(19) XLT

Number of windings, this transformers. (Also is the number of terminals) Default is 2. This property triggers memory allocation for the Transformer and will cause other properties to revert to default values.

Save All to File

Property Order:

Alphabetical

Numerical

```
/*
My first DSS transformer
*/

This is a Dy xfmr
new transformer.xfmr_name
  phases=3 windings=2
  bus1=Bus_A.1.2.3
  bus2=Bus_B.1.2.3.0
  conns=[delta, wye]
```

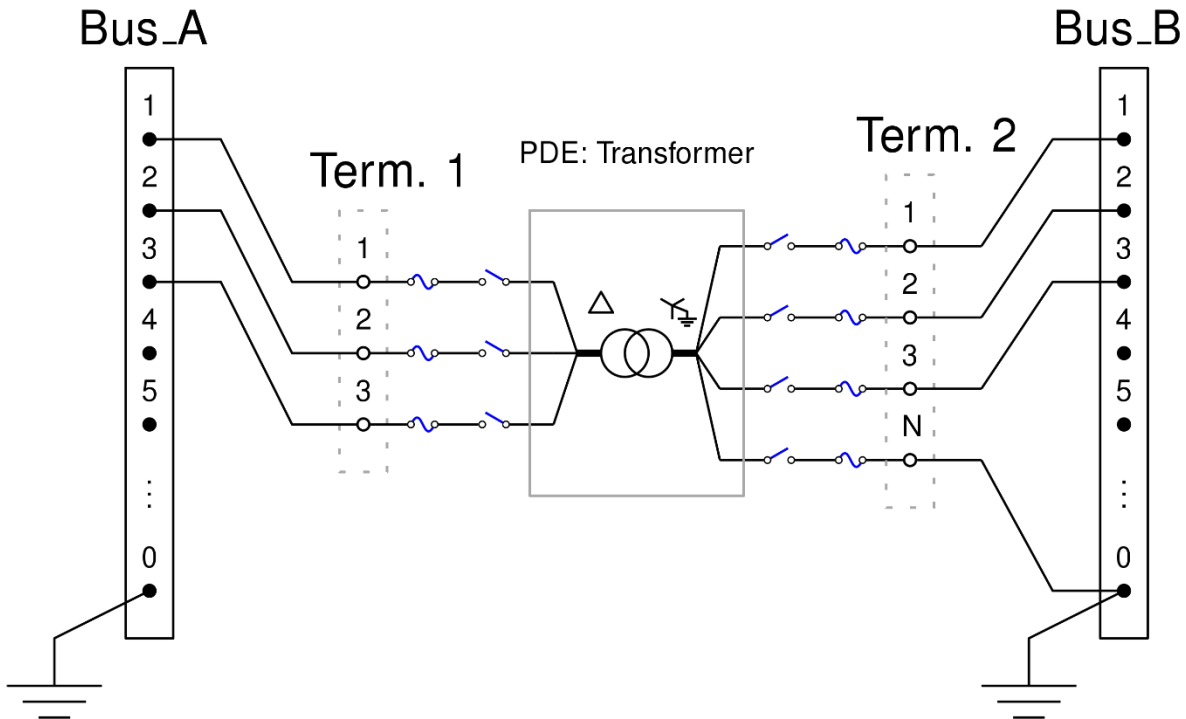


The parameter tag and equals sign in **keyword=value** are not needed if values are passed in numerical order. (See numerical order in OpenDSS command help)

Example: Solidly Grounded Transformer

Command syntax: **command** param_1, param_2 param_3

Comma, space or tab separated



Use ~ for line continuation

Use . for delimiting class, object, bus, node

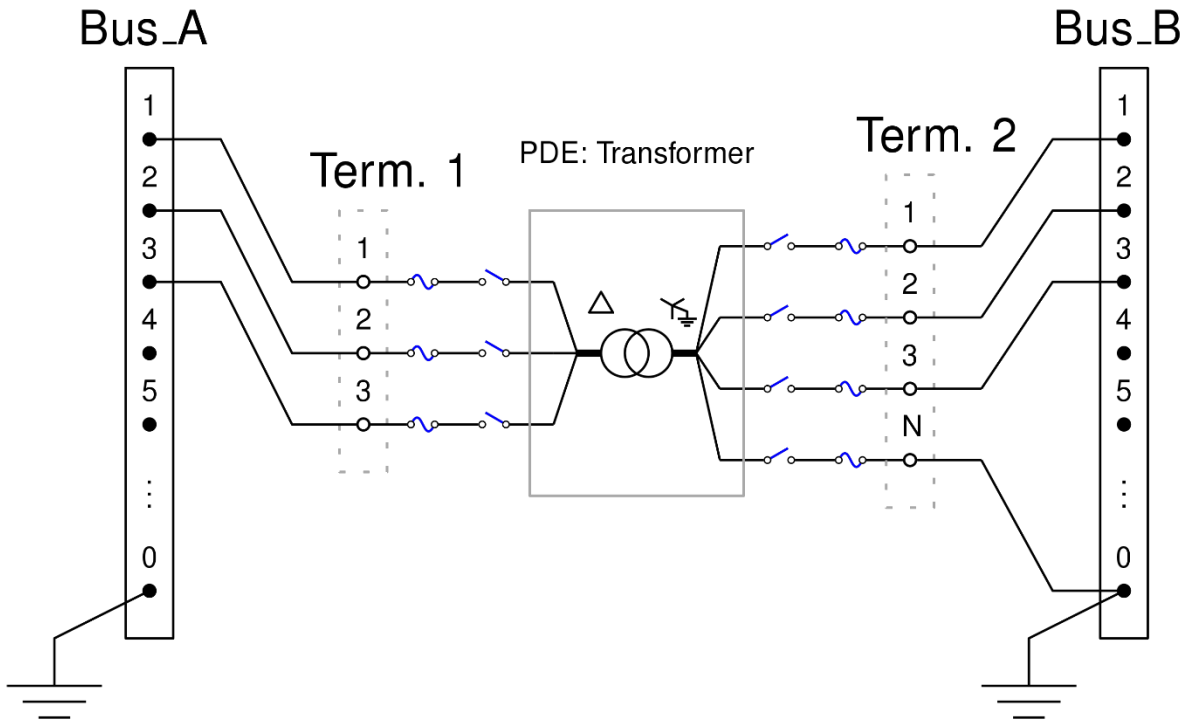
```
/*
My first DSS transformer
*/

! This is a Dy xfmr
New transformer.xfmr_name
~ phases=3 windings=2
~ Bus1=Bus_A.1.2.3
~ Bus2=Bus_B.1.2.3.0
~ coils=[delta, wye]
```

Example: Solidly Grounded Transformer

Command syntax: **command** param_1, param_2 param_3

Comma, space or tab separated

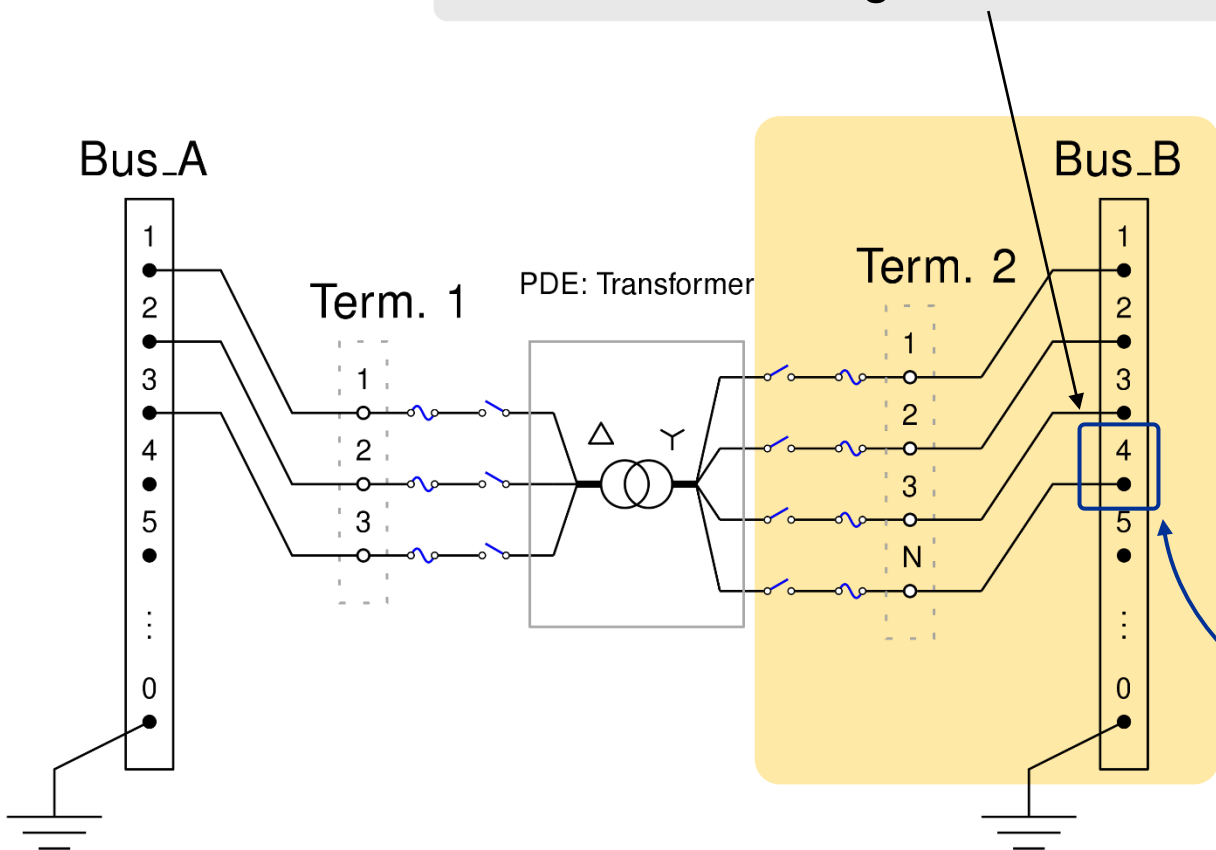


Use **[]** to create arrays. Comma or space to separate elements

```
/*  
My first DSS transformer  
*/  
  
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.0  
~ conns=[delta, wye]
```


Example: Ungrounded Transformer

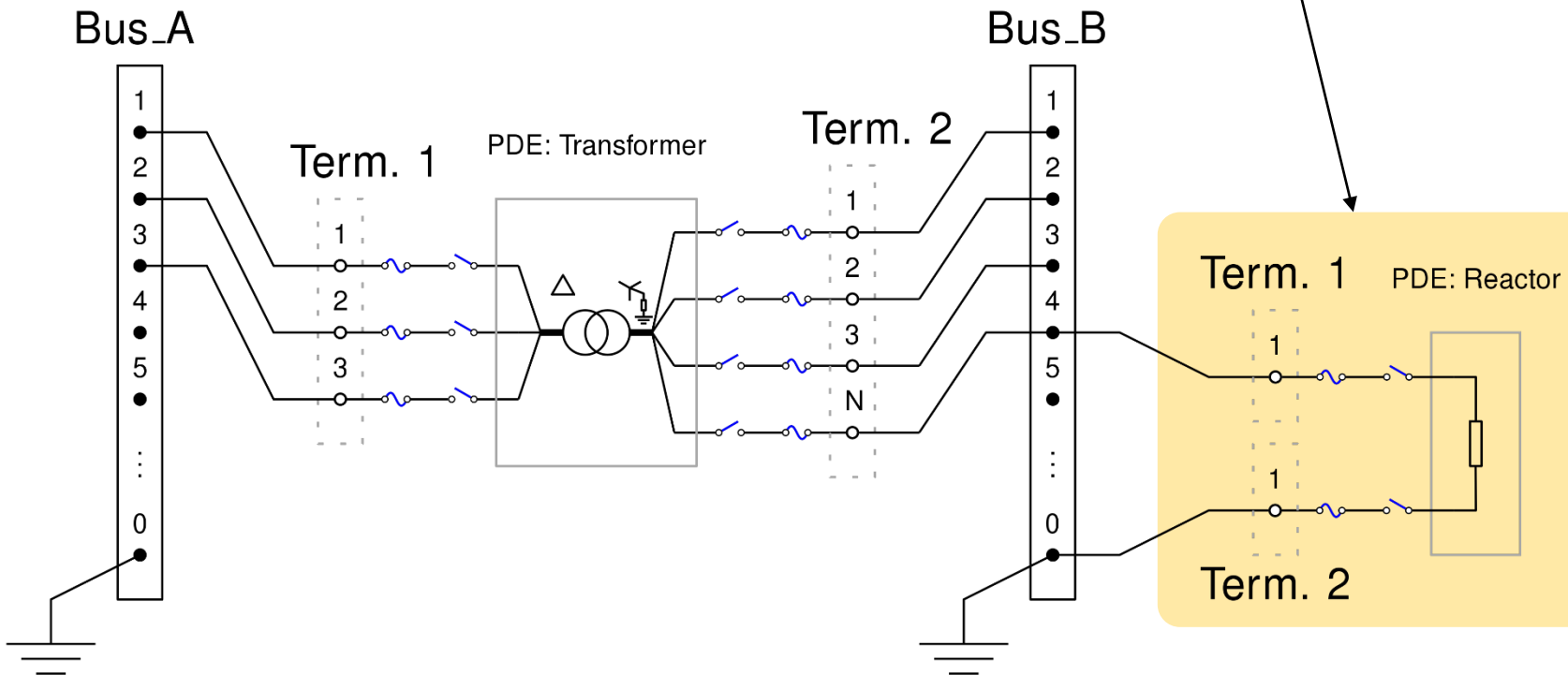
Connect neutral conductor to node 4 of the bus.
Neutral is floating now



```
/*  
My first DSS transformer  
*/  
  
! This is a Dy xfmr  
New transformer.xfmr_name  
~ phases=3 windings=2  
~ Bus1=Bus_A.1.2.3  
~ Bus2=Bus_B.1.2.3.4  
~ conns=[delta, wye]  
...
```

Example: Grounding Impedance

Connect both terminals of a reactor (another PDE) to *Bus_B* *None 4* and *Node 0*. The transformer is grounded again.



```

/*
My first DSS transformer
*/

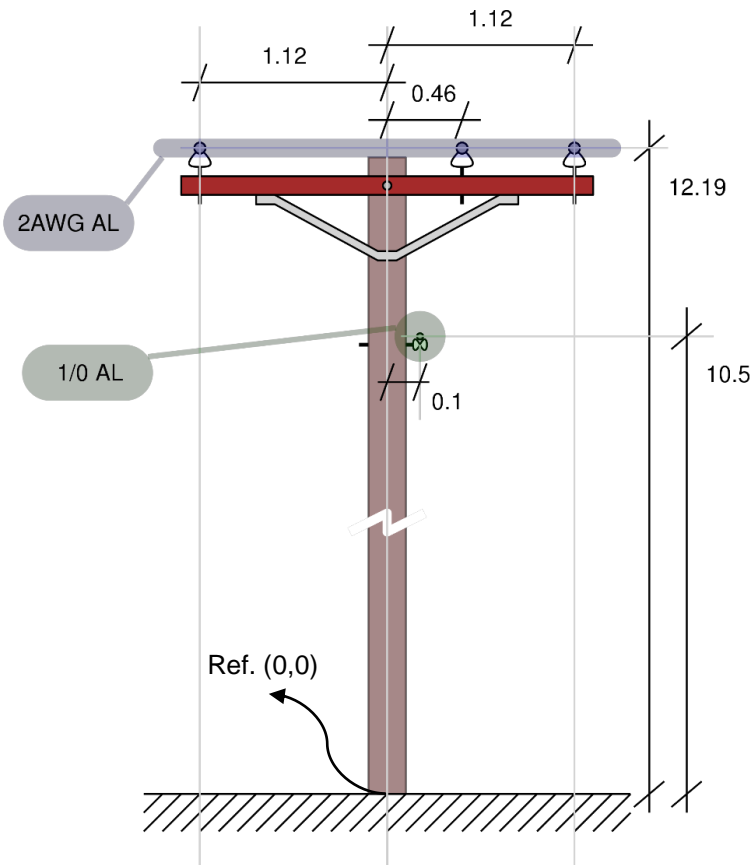
! This is a Dy xfmr
New transformer.xfmr_name
~ phases=3 windings=2
~ Bus1=Bus_A.1.2.3
~ Bus2=Bus_B.1.2.3.4
~ conns=[delta, wye]
...

New reactor.rg_name
~ phases=1
~ Bus1=Bus_B.4
~ Bus2=Bus_B.0
~ R=0.1 X=700.0
...

```

Example: Distribution Line Segment

If you know the per-length impedance matrices..



Use `[]` to create matrices.

Use `|` to separate rows.

! My first DSS line

New line.L1 bus1=A bus2=B phases=3

~ rmatrix=[0.9699 | 0.1200 0.9753 | 0.1181 0.1208 0.9714]

~ xmatrix=[0.7766 | 0.2905 0.7650 | 0.2682 0.3543 0.7733]

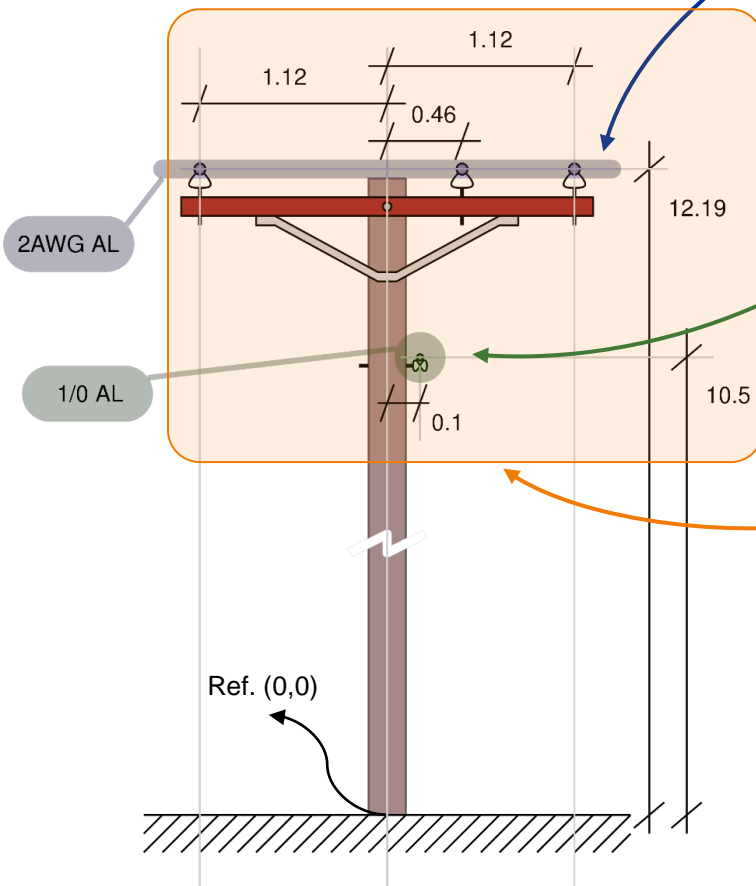
~ cmatrix=[7.4518 | -1.493 8.2716 | -1.029 -2.602 8.0307]

~ length=1 units=km

You can define all the matrix entries or just those of the lower triangle

Example: Distribution Line Segment

... or if you know the conductor and geometry details...



! Phase Conductor

```
New "wiredata.2AWG AL" Rac=0.86942 Runits=km GMRac=0.26924
~ GMRunits=cm diam=0.74168 radunits=cm
```

! Neutral Conductor

```
New wiredata.1/0AL Rac=0.54463 Runits=km GMRac=0.33833
~ GMRunits=cm diam=0.93472 radunits=cm
```

! Cross arm pole geometry details

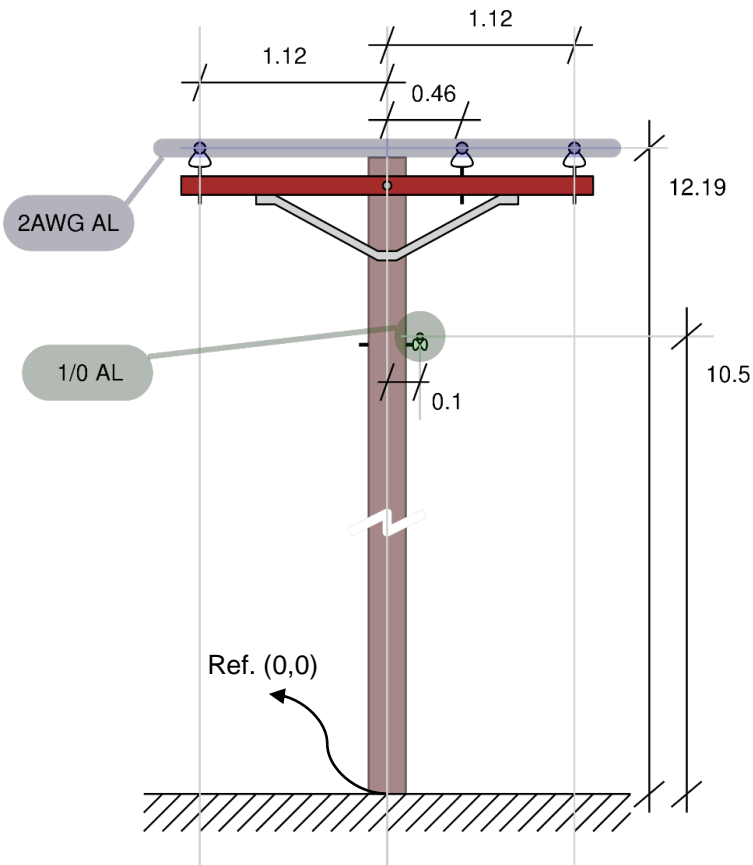
```
New linespacing.4KV_3PH_3CH nconds=4
~ x=[-1.1176 0.4572 1.1176 0.10160]
~ h=[12.1920 12.192 12.192 10.5664] units=m
```

! My second DSS line

```
New line.L2 bus1=A bus2=B phases=4 spacing=4KV_3PH_3CH
~ wires=["2AWG AL" "2AWG AL" "2AWG AL" 1/0AL] length=1
~ units=km
```

Example: Distribution Line Segment

... or if you know the conductor and geometry details...



Use `" "` if you want to have space characters in strings or names of DSS objects

! Phase Conductor

```
New "wiredata.2AWG AL" Rac=0.86942 Runits=km GMRac=0.26924
~ GMRunits=cm diam=0.74168 radunits=cm
```

! Neutral Conductor

```
New wiredata.1/0AL Rac=0.54463 Runits=km GMRac=0.33833
~ GMRunits=cm diam=0.93472 radunits=cm
```

! Cross arm pole geometry details

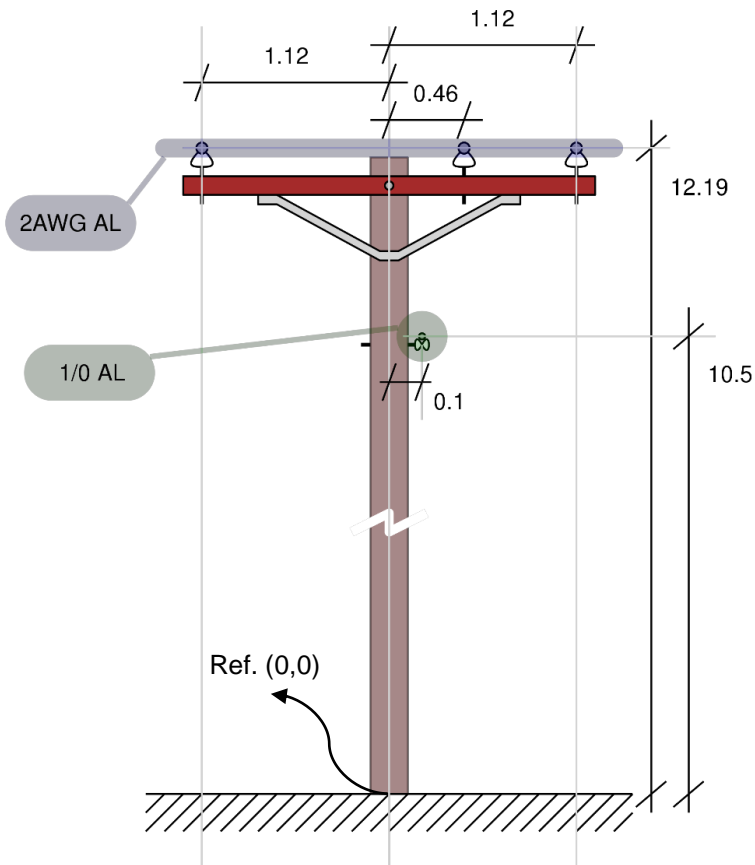
```
New linespacing.4KV_3PH_3CH nconds=4
~ x=[-1.1176 0.4572 1.1176 0.10160]
~ h=[12.1920 12.192 12.192 10.5664] units=m
```

! My second DSS line

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New line.L2 bus1=A bus2=B phases=4 spacing=4KV_3PH_3CH
~ wires=["2AWG AL" "2AWG AL" "2AWG AL" 1/0AL] length=1
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```

Example: Distribution Line Segment

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New wiredata.1/0AL Rac=0.54463 Runits=km GMRac=0.33833
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! Cross arm pole geometry details

```
New linespacing.4KV_3PH_3CH nconds=4
~ x=[-1.1176 0.4572 1.1176 0.10160]
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```

! My second DSS line

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New line.L2 bus1=A bus2=B phases=4 spacing=4KV_3PH_3CH
~ wires=["2AWG AL" "2AWG AL" "2AWG AL" 1/0AL] length=1
~ units=km
```

Summary: Commands and Scripting Characters

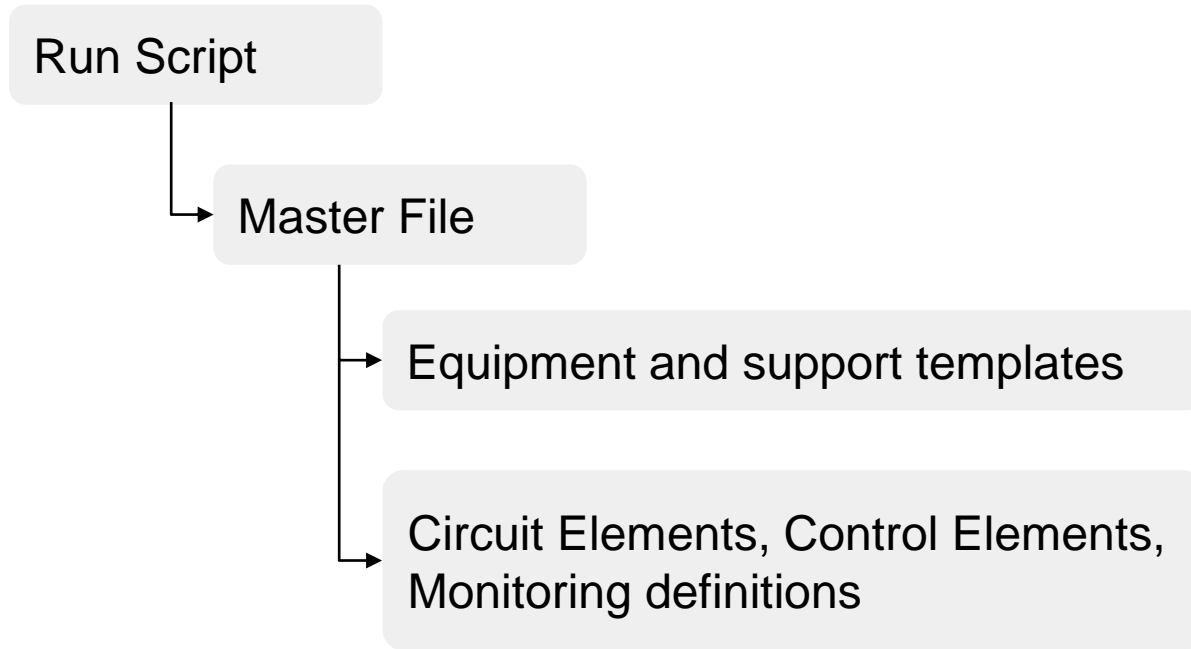
Scripting

Character	Description
~	Line continuation
[] () { } " ' `	Arrays, Matrices, Strings, Math Expressions
	Row delimiter in matrices
, space tab	Delimiter command parameters and array/matrix entries
.	Delimiter class-object, bus-node
=	Delimiter parameter tag and parameter value
! //	In line comments
/*...*/	Block comments

Commands (common)

Command	Description
New	Create new DSS elements
Edit	Edit existing DSS elements
Set	Define solution modes and options
Solve	Perform current solution mode
Show	Write selected results to text files
Export	Export solution variables in CSV or XML format
Plot	Plots results with built-in plotting features

Large Circuits – Script structure



This structure is not required but it helps to explore and organize your model. A single script can host an entire model.

```
// Master file for 8500-Node IEEE Test Feeder Case
// Balanced Load Case
```

```
Clear
```

```
Set DefaultBaseFrequency=60
```

```
New Circuit.IEEE8500
```

```
! Make the source stiff with small impedance
```

```
~ pu=1.05  r1=0  x1=0.001  r0=0  x0=0.001
```

```
Redirect LineCodes2.DSS
```

```
Redirect Triplex_Linecodes.dss
```

```
Redirect Lines.dss
```

```
Redirect Transformers.dss
```

```
//Redirect LoadXfmrs.dss      ! Load Transformers
```

```
Redirect LoadXfmrCodes.dss    ! Referencing XfmrCodes
```

```
Redirect Triplex_Lines.DSS
```

```
Redirect Loads.dss           ! Balanced Loads
```

```
Redirect Capacitors.dss
```

```
Redirect CapControls.DSS
```

```
Redirect Regulators.dss
```

```
! Let DSS estimate the voltage bases
```

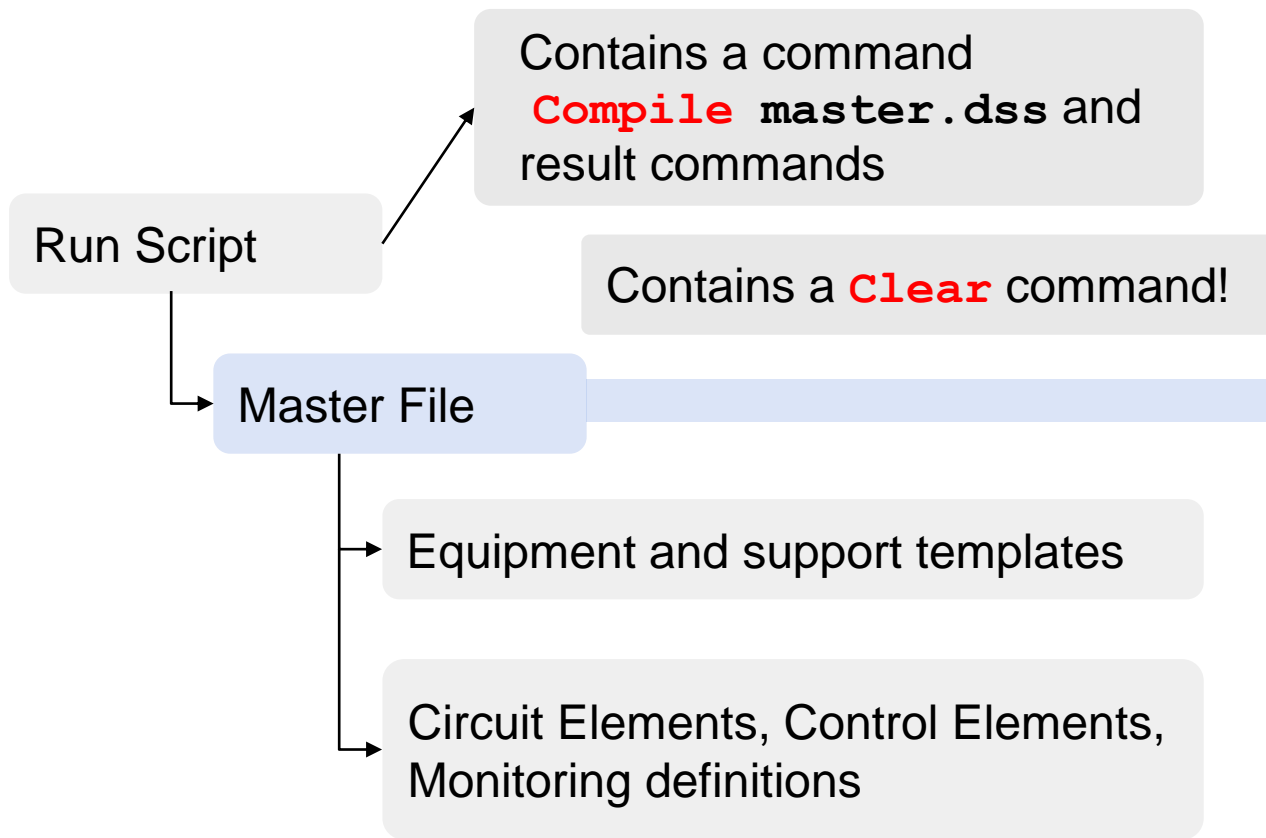
```
Set voltagebases=[115, 12.47, 0.48, 0.208]
```

```
Calcvoltagebases           ! This also establishes the bus list
```

```
! Load in bus coordinates now that bus list is established
```

```
Buscoords  Buscoords.dss
```


Large Circuits – Script structure



```
// Master file for 8500-Node IEEE Test Feeder Case
// Balanced Load Case
```

```
Clear
```

```
Set DefaultBaseFrequency=60
```

```
New Circuit.IEEE8500
```

```
! Make the source stiff with small impedance
~ pu=1.05 r1=0 x1=0.001 r0=0 x0=0.001
```

```
Redirect LineCodes2.DSS
```

```
Redirect Triplex_Linecodes.dss
```

```
Redirect Lines.dss
```

```
Redirect Transformers.dss
```

```
//Redirect LoadXfmrs.dss ! Load Transformers
```

```
Redirect LoadXfmrCodes.dss ! Referencing XfmrCodes
```

```
Redirect Triplex_Lines.DSS
```

```
Redirect Loads.dss ! Balanced Loads
```

```
Redirect Capacitors.dss
```

```
Redirect CapControls.DSS
```

```
Redirect Regulators.dss
```

```
! Let DSS estimate the voltage bases
```

```
Set voltagebases=[115, 12.47, 0.48, 0.208]
```

```
Calcvoltagebases ! This also establishes the bus list
```

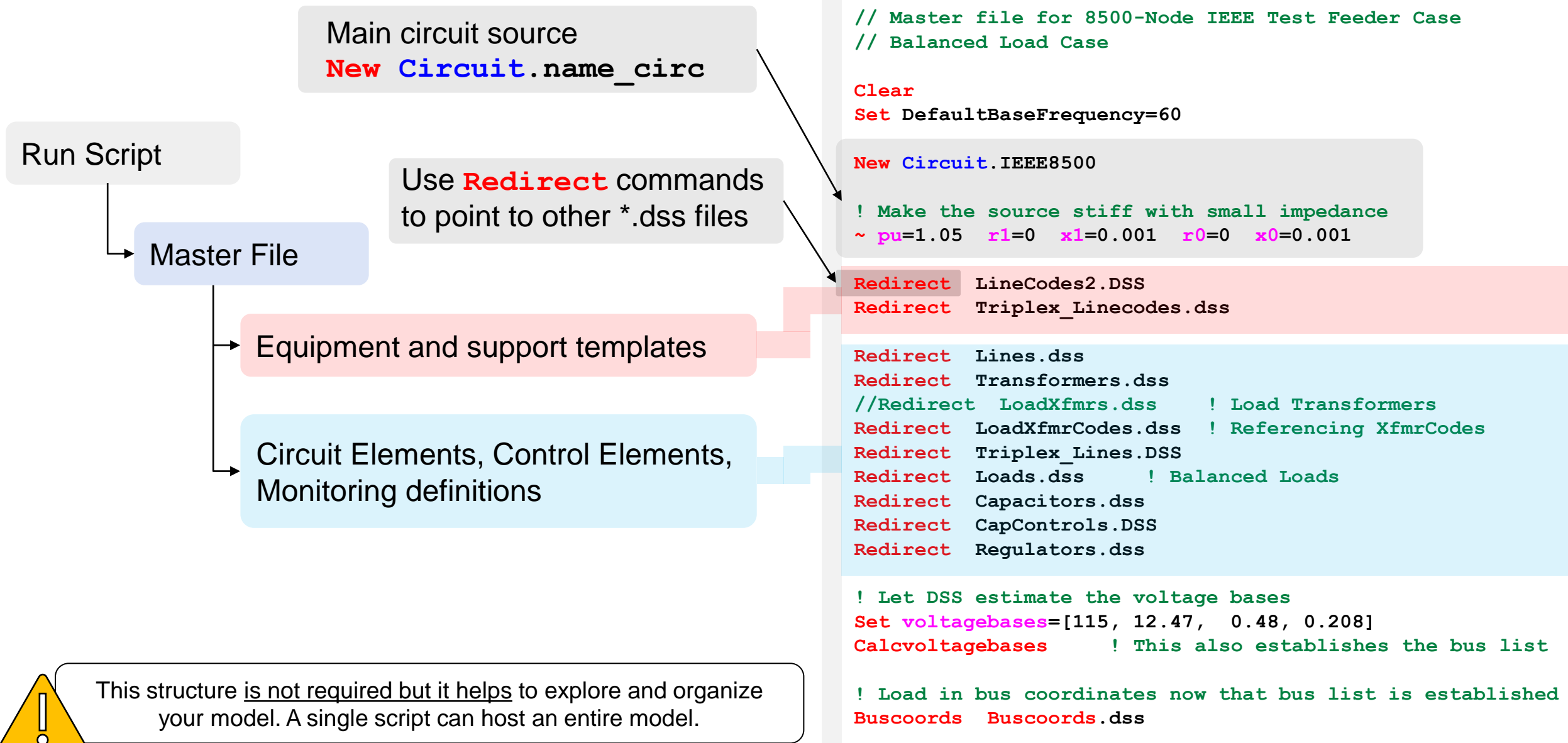
```
! Load in bus coordinates now that bus list is established
```

```
Buscoords Buscoords.dss
```



This structure is not required but it helps to explore and organize your model. A single script can host an entire model.

Large Circuits – Script structure



Large Circuits – Script structure

Main circuit source

```
New Linecode.1ph-x4_acsr4_acsr ...
New Linecode.1ph-xx4_acsr4_acsr ...
New Linecode.1ph-x2_acsr4_acsr ...
New Linecode.1ph-x4_acsr4_wpal ...
New Linecode.3ph_h-4_acsr4_acsr4_acsr4_acsr ...
...
LineCodes2.dss
```

```
New Line.HVMV_Sub_connector ...
New Line.LN5502549-1 ...
New Line.LN6259988-1 ...
New Line.LN6077796-1 ...
New Line.LN5835135-2 ...
New Line.LN5896826-1 ...
New Line.LN5714038-1 ...
...
Lines.dss
```

```
// Master file for 8500-Node IEEE Test Feeder Case
// Balanced Load Case
```

```
Clear
Set DefaultBaseFrequency=60
```

```
New Circuit.IEEE8500
```

```
! Make the source stiff with small impedance
~ pu=1.05 r1=0 x1=0.001 r0=0 x0=0.001
```

```
Redirect LineCodes2.dss
Redirect Triplex_Linecodes.dss
```

```
Redirect Lines.dss
Redirect Transformers.dss
//Redirect LoadXfmrs.dss ! Load Transformers
Redirect LoadXfmrCodes.dss ! Referencing XfmrCodes
Redirect Triplex_Lines.DSS
Redirect Loads.dss ! Balanced Loads
Redirect Capacitors.dss
Redirect CapControls.DSS
Redirect Regulators.dss
```

```
! Let DSS estimate the voltage bases
Set voltagebases=[115, 12.47, 0.48, 0.208]
CalcVoltagebases ! This also establishes the bus list

! Load in bus coordinates now that bus list is established
Buscoords Buscoords.dss
```



OpenDSS interface

OpenDSS Data Directory: C:\OpenDSS\Distrib\IEEE8500-Node\

File Edit Do Set Make Export Show Visualize Plot Reset Help

PDelements

Line

2002200004641085_SW

C V P

Base Frequency = 60 Hz

C:\OpenDSS\Distrib\IEEE8500-Node\Master.dss

Results for Actor ID # 1

CPU selected : -1

Status = SOLVED

Solution Mode = Snap

Number = 100

Load Mult = 1.000

Devices = 6106

Buses = 4876

Nodes = 8531

Control Mode =STATIC

Total Iterations = 2

Control Iterations = 1

Max Sol Iter = 2

- Circuit Summary -

Year = 0

Hour = 0

Max pu. voltage = 1.0503

Min pu. voltage = 0.92561

Total Active Power: 11.9835 MW

Total Reactive Power: 1.38497 Mvar

Total Active Losses: 1.21028 MW, (10.1 %)

Total Reactive Losses: 2.76818 Mvar

Frequency = 60 Hz

Mode = Snap

Control Mode = STATIC

Load Model = PowerFlow

// Master file for 8500-Node IEEE Test Feeder Case

// Balanced Load Case

Clear

Set DefaultBaseFrequency=60

New Circuit.IEEE8500

! Make the source stiff with small impedance

~ pu=1.05 r1=0 x1=0.001 r0=0 x0=0.001

Redirect LineCodes2.DSS

Redirect Triplex_Linecodes.dss

Redirect Lines.dss

Redirect Transformers.dss

//Redirect LoadXfmrs.dss ! Load Transformers

Redirect LoadXfmrCodes.dss ! Referencing XfmrCodes

Redirect Triplex_Lines.DSS

Redirect Loads.dss ! Balanced Loads

Redirect Capacitors.dss

Redirect CapControls.DSS

Redirect Regulators.dss

! Let DSS estimate the voltage bases

Set voltagebases=[115, 12.47, 0.48, 0.208]

Calc voltagebases ! This also establishes the bus list

Transformer.dss masterMatlab.dss Master.dss Script14 Master.dss Run_8500Node.dss Master.dss

Messages

OpenDSS - C:\OpenDSS\Distrib\IEEE8500-Node\Master.dss

Summary

Results

Memory: 86792K

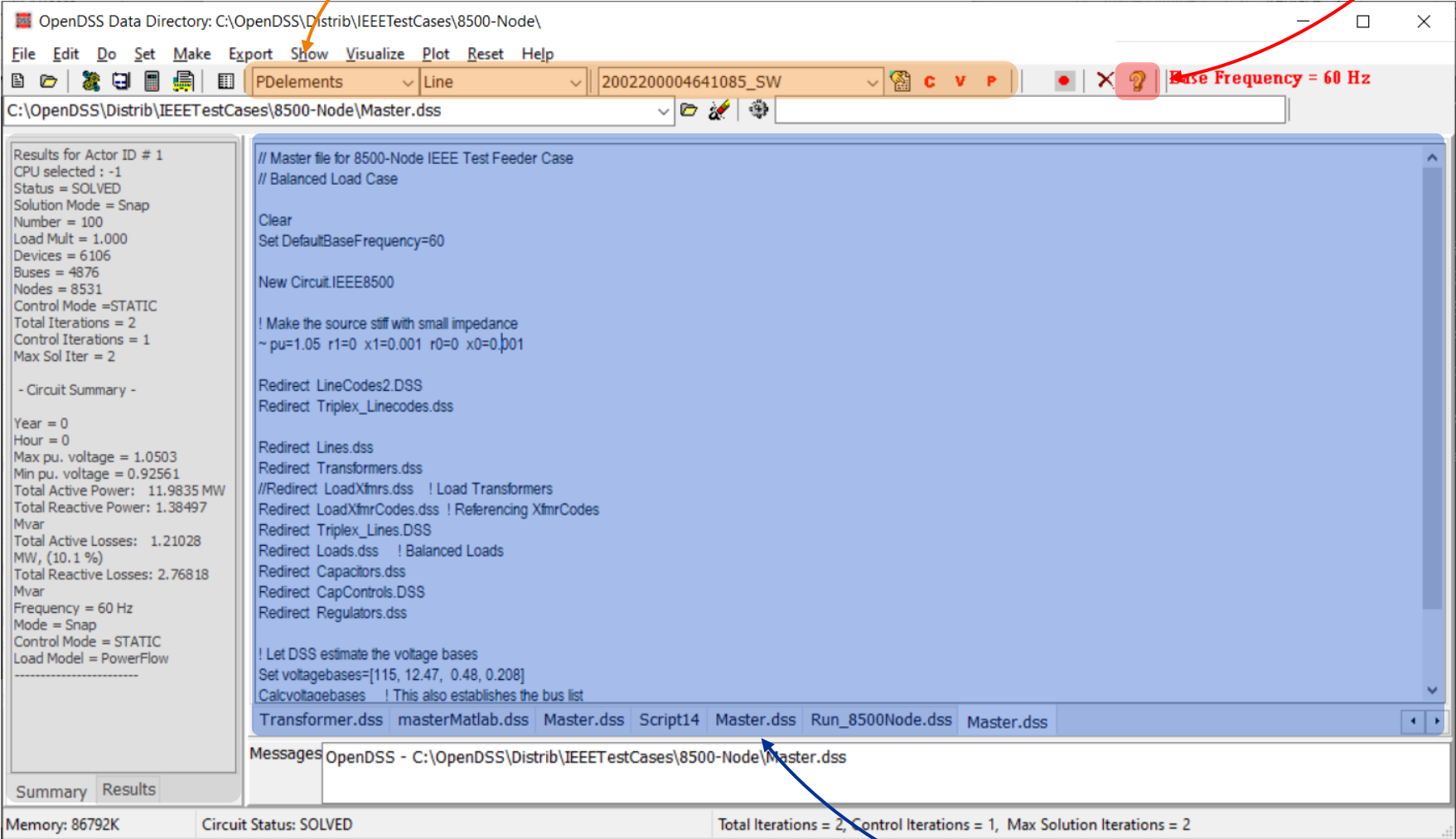
Circuit Status: SOLVED

Total Iterations = 2, Control Iterations = 1, Max Solution Iterations = 2

OpenDSS interface

DSS Element toolbar

Command and Properties help



Solution / Results summaries

DSS script editor / navigator

DSS Scripts in Text editor

```
1 // Master file for
2 // Balanced Load Case
3
4 Clear
5 Set DefaultBaseFreq
6
7 New Circuit.IEEE850
8
9 ! Make the source
10 ~ pu=1.05 rl=0 xl
11
12 Redirect LineCodes
13 Redirect Triplex_1
14
15 Redirect Lines.dss
16 Redirect Transform
17 //Redirect LoadXfr
18 Redirect LoadXfmr
19 Redirect Triplex_1
20 Redirect Loads.dss
21 Redirect Capacitor
22 Redirect CapControl
23 Redirect Regulator
24
25 ! Let DSS estimate
26 Set voltagebases=[
27 Calcvoltagebases
28
29 ! Load in bus coord
30 Buscoords Buscoord
```

Use a text editor like **Notepad++** or **EditPlus** to better visualize your OpenDSS scripts

Import the syntax file from this folder
OpenDSS/Examples/SyntaxFiles

A restart of the text editor might be required



Live Demo



Questions ??

A blue-tinted photograph of four people, two men and two women, standing in a row. They are all wearing white lab coats with the EPR2 logo on the left chest. The woman on the far right is also wearing a white hard hat. They are all smiling and looking towards the camera. The background is a solid blue color.

Together...Shaping the Future of Energy™