# OpenDSS Power Flow Method

Roger C. Dugan, EPRI  
November 2017

Nearly all variables in the formulation result in a matrix or an array (vector) to represent a multiphase system. Many of the variables are complex numbers representing the common *phasor* notation used in frequency-domain ac power system analysis.

OpenDSS uses a fairly standard Nodal Admittance formulation that can be found documented in many basic power system analysis texts. The Arrillaga and Watson textbook is useful for understanding this because it also develops the admittance models for harmonics analysis similarly to how OpenDSS is formulated.

A *primitive* admittance matrix, *Yprim*, is computed for each circuit element in the model. These small matrices are used to construct the main *system* admittance matrix, *Ysystem*, that knits the circuit model together. The solution is mainly focused on solving the nonlinear system admittance equation of the form:

*IPC(V) = YsystemV*

where,

*IPC(V)* = compensation currents from Power Conversion (PC) elements in the circuit

The currents injected into the circuit from the PC elements, *IPC(V)*, are a function of voltage as indicated and represent the nonlinear portion of the currents from Load, Generator, PVsystem, and Storage elements in the circuit.

There are a number of ways this set of nonlinear equations could be solved. The most popular way in OpenDSS is a simple *fixed point* method that can be written concisely:

*Vn+1 = [Ysystem]-1 IPC(Vn) n = 0, 1, 2, … until converged*

In words:

After building *Ysystem,* start with a guess at the system voltage vector, *V0*, and compute the compensation currents from each PC element to populate the *IPC* vector. Using a sparse matrix solver, compute the new estimate of *Vn+1*. Repeat this process until a convergence criterion is met.