HPPOW version 2.0 HP49G

(Optimized Version)

#Lib : *1128*

Size : *15,5 kB*

Programming Language: *System RPL*

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HPPOW is a small packet for solve Load Flows for a Power System or Distribution Lines using Gauss-Seidel's and Newton Raphson's methods. For manipulate this program, I assume that user knows about Power System Analysis and in especial Load Flows calculation and per unit system **(p.u.).**

Installing the library:

Unzip the **hppow20.zip** file to a folder in the computer or your hard drive, noting the location, copy or transfer the **hppowv20en.lib** file into your calculator with your serial interface, then the file will have been transferred into your HP49G, put the library in the stack and press 2 (port in which you will install the library) and then press STO, at once restart your HP49G pressing simultaneously **ON+C** and **OK**, library installed.

Setting the Decimal Punctuation of the HP (Fraction Mark):

The HP calculators come, by default, configured as decimal separation the period **(.)**, e.g.: **45.23 0.45 0.078** and for separation of lists and of complex numbers the **comma** (,), e.g.: **{ 45 , 4 , 78 } (45 , 56) (12 , ∠30),** now then, according to international current standards, the decimal separation should be the **comma** (,), e.g.: **45,23 0,45 0,0078** and for separation of lists and of complex numbers in the HP will be the **period and comma** (;), e.g.: **{ 45 ; 4 ; 78 }**
(45 ; 56) (12 ; ∠30) etc., then, following these current standards, this manual will use for decimal separation or fraction mark the **"comma"** and for lists and complex numbers the **"period and comma"**, then, you should change the format of decimal separation for the current (actual).

An observation that you will have is the angular format, choose the one that you want, Radians or Sexadecimal Degrees.

Note:

If you prefer the classic decimal separation, don't worry, that the program works perfectly, be only careful when entering the data and maintain the decimal configuration that you elected.

Running the program

Go to the library and you will find two menus

SETUP: Press only once and the directories and variables that this program uses will be installed in the Main Directory **Home**, wait some moments until this finishes.

ABOUT-HPPOW: Program reference

En el directorio **HOME** se habrá creado un directorio llamado **HPPOW**, y dentro de éste variables que usa el programa y un directorio llamado **FILES** en donde se guardarán archivos que usted desee para cada caso de resolución de flujos de potencia.

In the **Home** directory, a called directory **HPPOW** will have been created, and inside this, variables that it uses this program and a called directory **FILES** where it will save files that you want for each case of resolution of Load flows.

Inside **HPPOW** directory you will find variables that **you won't should delete.** In the menu you will find a variable with the name **SOLVE** that is the main variable, press **SOLVE** and will appear a submenu or menu of input of data, **PLEASE THE DATA SHOULD BE ENTERED IN ORDER AS APPEARS IN THE MENU, LIKE NEXT IS DESCRIBED**:

1º Bus?:

Enter the number of buses that your system has (2,3,4,…n, etc), e.g.:

2º Type?:

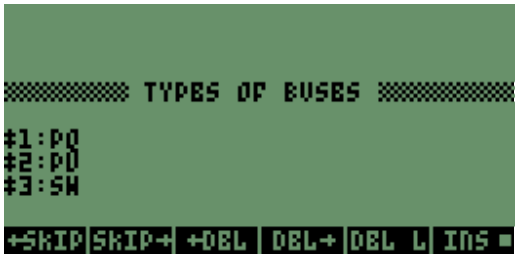
Enter the types of buses for each bus that you chose.

Write **PV** for a bus PV **(Voltage Bus, Specified Voltage Bus or Generation Bus)**

Write **PQ** for a bus PQ **(Normal Bus or Load Bus)**

Write **SW** for a bus SLACK or SWING**. (Reference Bus)**

Example:



3º V(0)?:

You should enter the **Module (Absolute Magnitude) of the voltage** for each bus **in per unit (p.u.)** (Initial Voltages).

E.g.:

1 PV = 1 The program will recognize as **(1 ∠ 0º)**

2 PQ = 0,98 The program will recognize as **(0,98 ∠ 0º)**

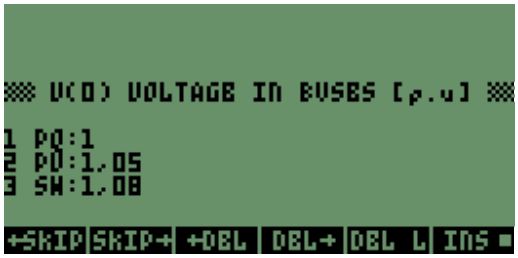
3 SW = 1.02 The program will recognize as **(1,02 ∠ 0º)**

If you prefer, you can enter the module (Absolute Magnitude) and angle of the voltage of each bus in **POLAR NOTATION OF COMPLEX NUMBERS** and in **per unit (p.u.).**

In a **PV** bus, the voltage module (magnitude) is known, **(1 p.u.; 1,01 p.u.; etc)** and this will be maintained constant during everything the solution (resolution) process, but the voltage angle is unknown and the program will recalculate it. You should only write the module (magnitude) value of the voltage, e.g. **PV = 1** or if you want **PV = (1 ∠ 0)**; **PV = 1,01** or if you want **PV = (1,01 ∠ 0)**, etc.

In a **PQ** bus, the module (magnitude) and angle of the voltage are unknown in the bus, the program will calculate them and you should write the initial data as **1** or **(1 ∠ 0) ALWAIS!!!.**

In a bus **Slack** or **Swing** the module (magnitude) and the angle of the voltage is known and will be maintained invariable or constant during everything the solution process, we know that a **Slack** bus is a reference bus. You should only write the module (magnitude) value of the voltage, e.g.: **SW = 1** or if you want **SW = (1 ∠ 0)**; **SW = 1,01** or if you want **SW = (1,01 ∠ 0)** ; **SW = 0,98** or if you want **SW = (0,98 ∠ 0)**; etc.



4º SgSd?: (Generation Power Sg and Demanded Power (load) Sd)

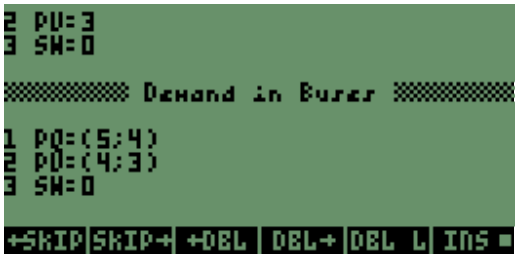
With this command you should enter in **RECTANGULAR NOTATION OF COMPLEX NUMBERS** the generated power if the bus has generators and the demanded power (load) if the bus has load. You should enter in rectangular notation **(Re;Im)** (Active Power, Reactive Power)), (**P ; Q),** in **MW** and **Mvar** or changing with **SETUP** to per unit **p.u**.

In a **PV** bus, the **generated active power** value (data) is known, but the generated reactive power value is unknown, then, it should be written a **0** as initial value for the **generated reactive power**. The program will calculate the true value of **Q**, now, you should only write the generated active power value, e.g.: **PV =** 2 or also **PV = (** 2 ; 0 **)** . If this bus is not generating anything, simply, it will be written **0** or **(0 ; 0)**.

In a **PQ** bus, the active power and reactive power generated are known, then, you should **ALWAYS** enter data in **RECTANGULAR NOTATION OF COMPLEX NUMBERS** (Re ; Im) or (P ; Q), e.g.: **PQ = (** 2 ; 1,5 **)** , **PQ = (** 1,3 ; 0,5 **)**. It can be that this bus doesn't have generation, then, you should write **0** or **(0 ; 0)** in generation.

In a **Slack** Bus, the generation is unknown, this is, the active power and reactive power generated are unknown, the program will calculate them, you should write **ALWAYS 0** or **(0 ; 0)** as initial data that at once the program will recalculate these values.

Scrolling the cursor plus below, you should enter data of the **Demand** or **Load** for each bus, or the demanded power (consumption power) of each bus, and also you should enter data in **RECTANGULAR NOTATION OF COMPLEX NUMBERS** (Re;Im) or (P,Q) in **MW and Mvar** or en per unit **p.u**. according to your setting. It can be that in a bus doesn't have Demand or Load, then, you should write **0** or **(0 ; 0).** Example:



If you are going to work with only active power, then only it will be enough with entering **Active Power** data of generation or of demand (load) without the necessity of writing a complex number. E.g.:

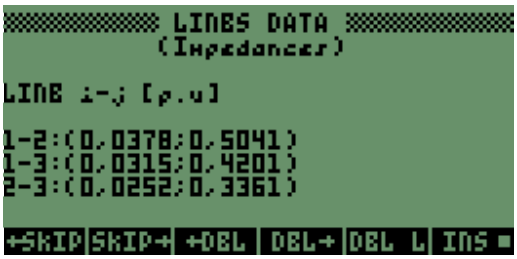
1 PV = 2 The program will recognize as **(2 ; 0)** , this is 2 MW (or their equivalent in p.u.) and 0 Mvar

2 PQ = 1.35 The program will recognize as **(1,35 ; 0)** , this is 2 MW (or their equivalent in p.u.) and 0 Mvar

3 SW = 0 The program will recognize as **(0 ; 0)** , this is 2 MW (or their equivalent in p.u.) and 0 Mvar

5º Lnes?:

With this command you enter the data of lines, from a bus to other. you will see two options, one of entering data with impedances and the other one with admitances, the data should be in **RECTANGULAR NOTATION OF COMPLEX NUMBERS (Re;Im),** where the real part corresponds to the resistance in **p.u**. of the line and the imaginary part corresponds to the reactance in **p.u.** of the line, this if the entry (Input of data) is in impedances. In an entry of admitances (Input of data in admitances), the real part will correspond to the conductance in p.u. of the line and the imaginary part will correspond to the susceptance in p.u. of the line. For example:



Note: The Line Model will be the PI model

Depending in how the lines are interconnected to each bus, the program will show to you for a number of buses that you have entered, the possible interconnections of the lines to the buses, if in your system a line doesn't exist, simply you should write **0 (Zero).** E.g.:

LINE

1-2 = (0,34 ; 0,23)

1-3 = 0 "Zero" indicates that doesn't exist line from bus 1 to 3

2-3 = (0,24 ; 0,11)

Shunt Admitances

Scrolling the cursor plus below, you should enter the modules (Magnitudes) of **Shunt Admitances (Admitance in Parallel)** of the lines in **per unit**. E.g.:

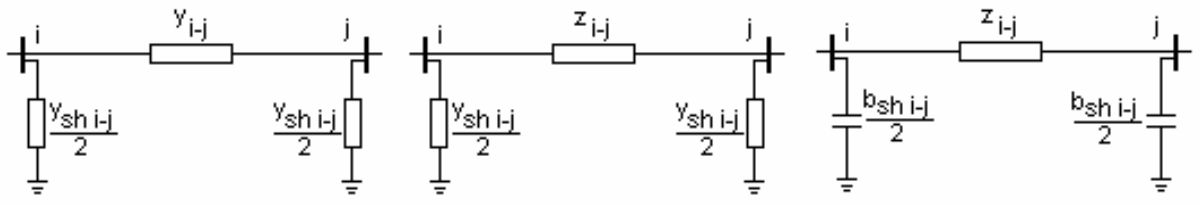
`Yshi-j/2` (Shunt Admitance)

1-2 = 0,00070 The program will recognize as **(0 ; 0,00070)** or $\frac{y_{Sh\ 1\text{-}2}}{2} = 0{,}00070$ p.u.

1-3 = 0,00045 The program will recognize as **(0 ; 0,00045)** or $\frac{y_{Sh\ 1\text{-}3}}{2} = 0{,}00045$ p.u.

2-3 = 0,00023 The program will recognize as **(0 ; 0,00023)** or $\frac{y_{Sh\ 2\text{-}3}}{2} = 0{,}00023$ p.u.

You can also enter the **Shunt Admitance (Admitance in Parallell)** of each line in **RECTANGULAR NOTATION OF COMPLEX NUMBERS (Re;Im),** in the reality the real part of this Shunt Admitance (Conductance) is very small and generally will be assigned as **0 (zero)**, but the imaginary part (Susceptance) has a value that should not be ignored, e.g. **(0;0,0045) (0;0,078)** etc.

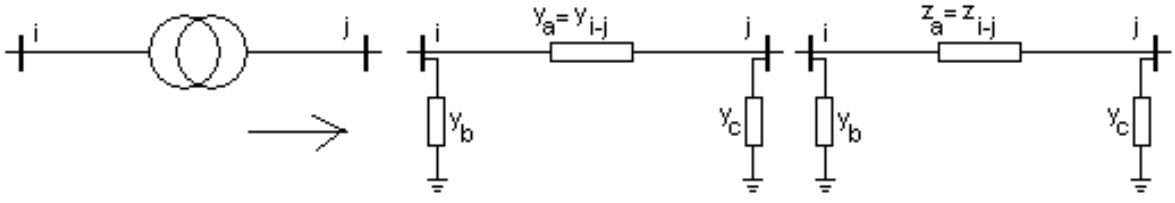


PI model of a Medium and Long Line

In the same way, if the program requests you data of Shunt Admitance of lines that your system doesn't have, then you should write **0 (Zero).**

Between a bus and the other, it can be that we have a Power Transformer (Reducer or Elevator), if it was more exact the model of the system, then for this case, it should be had the **PI model of the transformer** and instead of entering the Shunt Admitance of the line, where is located the transformer, it should be written two values of admittances together (Data in Admitances). E.g.:

Line 1-3: (1 to 3) (1,001;0,001)(1,01;0,008) where the first complex number (1,001;0,001) corresponds to the Shunt Admitance of the primary side of the transformer and the second complex number (1,01;0,008) corresponds to the Shunt Admitance of the secondary side of the transformer and between **1** and **3 (i - j)** there will be another admitance called of transference that will be written as if was a line.



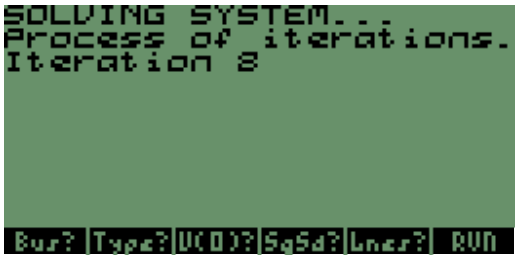
PI model of a Transformer (Reducer or Elevator)

6º RUN:

With this command the program will solve the System and according to system size, the program will show you the obtained results. The program by default will make 10 iterations, but you can increase the number of iterations to have more precision in the results

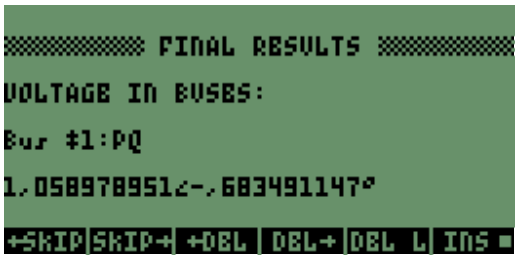
NOTE:

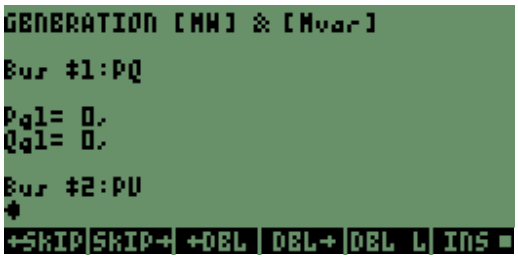
You should not press this command if you had not still entered correctly the data. Make sure that your data are correct. In case you have entered incoherent or incomplete data and your calculator doesn't respond, press CANCEL and if this doesn't work, your HP should be restarted, pressing ON-C or inserting a paper clip into the reset hole in the back of the 49G.

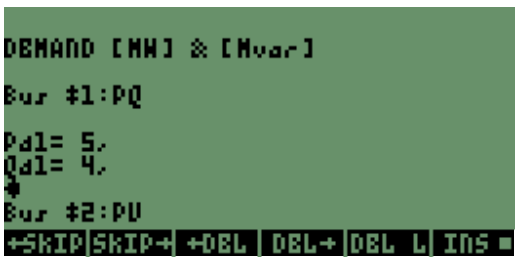


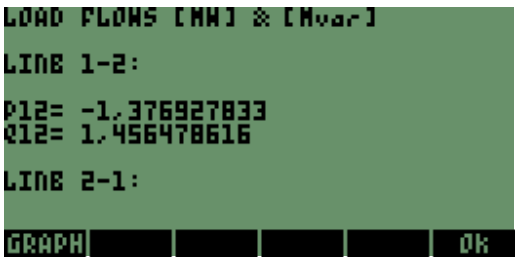
7º FLOWS: FOR YOU SEE THIS NEW MENU, PRESS *NEXT*

This command will show you again the obtained results









8º →ITER:

This command is very useful to see the results for each iteration.

9º SET:

With this command, you can change the configuration of **HPPOW** like next is described:

- You can choose the resolution method of flows that you want (Newton-Raphson or Gauss-Seidel)
- You can choose the resolution mode (**Auto:** so that the program solves your system and finishes the iterations when a certain limit of convergence error has been completed or **Def:** "defined" when you tell to the program how many iterations it will make to solve your system without considering the convergence)
- You can change the base power of your system in MVA,
- You can change the number of iterations (by default the program will make 10 iterations, valid if you chose as resolution mode **Def.**)
- You can change the convergence error in (%) (by default the program will work with 0,3%, valid if you chose as resolution mode **Auto**)
- You can choose the unit power that it will use the program (MW and Mvar) or in p.u. (per unit).

10º OPEN:

With this command, you can open a file any that you have kept and to be able to see the results for a type of special case that you have kept.

11º SAVE:

This command is very useful when keeping a special case of resolution of Power Flows for then to be able to load it or to open it to see the results..

Final considerations

Inside this file **hppowv20.zip**, you will find a called file **Example.var.** Load this file to your calculator and run it, this program will install an example file in the called directory **FILES** and from the menu with **SOLVE** open this file with **OPEN** and press **RUN**, you will see how **HPPOW** works and also you will see how the data were introduced in that example.

The advantage of **HPPOW** is that you can **edit** the data that you had entered without necessity of entering them again, these data are stored in the variables **TYPE**, **VINI**, **SGSD** and **DATA**, there with only to edit one of them and replacing it again, you will have the results that you want.