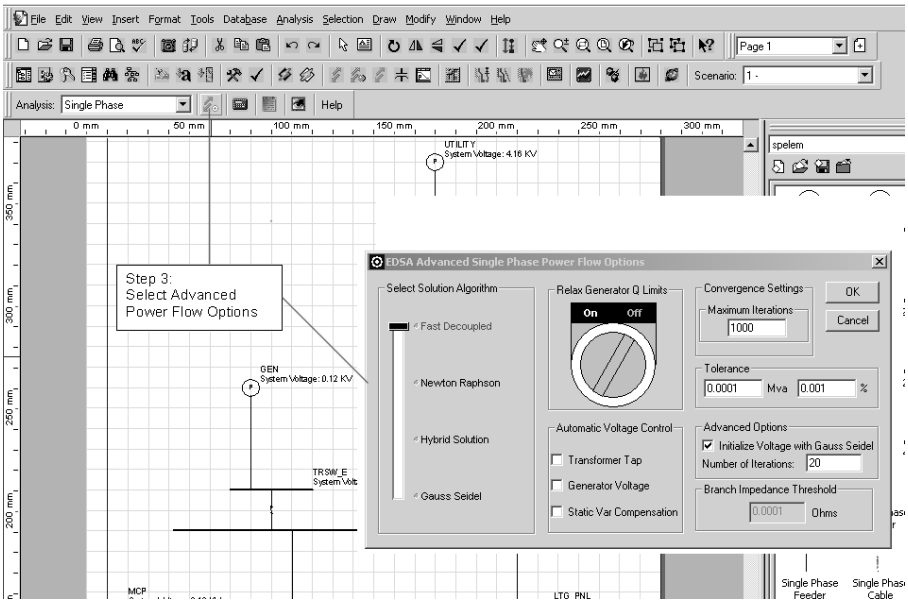
Advanced Single Phase Power Flow



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Note: You can view this manual on your CD as an Adobe Acrobat PDF file. The file name is:

- Advanced Single Phase Power Flow — Adv_Single_Phase_Power_Flow.pdf

You will find the Test/Job files used in this tutorial in the following location:

- C:\DesignBase\Samples**1Phase** = **Single Phase Load Flow**

  Test Files: **1PH_FAANEW, 1PH_XFMRLOAD, 1PH_XFMRNEW, SINGLE2, SINGLE, SINPHASE**

ADVANCED SINGLE-PHASE POWER FLOW PROGRAM

TUTORIAL

Most large power networks are three phase, but sometimes a single-phase transformer may be connected either phase-to-phase or phase to ground to serve an isolated single-phase load.
One needs to mention that single-phase transformers are commonly used in residential areas and within commercial buildings at 240/120 V, in USA or 400/230 in Europe. To provide the dual voltage in the secondary side, the transformer secondary is center-tapped and center leg grounded (some times known as Scott connection). This transformer is called single-phase mid tap transformer.
Loads rated 120 V or 230 V are connected from the “hot” wire to the ground. Heavier loads requiring 240 V or 400 V are connected between the two “hot” phases (or phase-to-phase connection). However, short-circuits can occur between the two hot phases or a hot phase to ground.
This Tutorial will illustrates the EDSA Advanced Single Phase Power Flow program capabilities, and the instructions for creating a single-phase network and performing the load flow analysis.

1 Program Capabilities

The EDSA Advanced Single Phase Power Flow program (EASPPF) is an advanced and robust algorithm, which incorporates state-of-the-art solution techniques applicable to large and complex systems. The EASPPF program is equipped with an easy to use graphical interface. EDSA Advanced Single Phase Power Flow allows load flow analysis on a single-phase network, which is:

- tapped from a three-phase network with a line-to line or line-to ground connection to the utility bus;
- tapped from a single-phase utility source with 2-poles;
- tapped from a mid tap transformer;

The program’s modeling capabilities include:

- Generator Local/Remote Bus Voltage Control.
- Three solution techniques: Newton-Raphson Fast De-coupled, Advanced Gauss Seidel, and Relaxed Generator Reactive Power (Q) limits.
- Bus types can be defined as follows: “out of service”, “load”, “generator”, or “Swing Bus”
- Multiple Swing Busses/Co-Generation Units
- Multiple Independent Islands
- Generator models can have different modes of operation: “fixed power output”, “fixed active power & control voltage at the terminal or at a remote locations”.
- Transformers with fixed tap, voltage control, phase shifter (active power control), and reactive power control.
- Transformers can be equipped with Under Load Tap Changers for local and remote bus voltage control "**ULTC**".
- SVC “Static-Var Compensation” and Shunt capacitor and reactors can also be modeled.
- No bus-numbering limitations.

The Program output includes:

- Bus voltage and angle.
- Reactive power, terminal voltage and remotely controlled bus (if any), power factor for generators.
- Active, reactive power flows and flow power factor through branches.
- Line and total system losses.
- Total Generation, Consumption, Losses, and System Mismatch
- Voltage Violations report vs. user-defined values.
- Line Loading Violations vs. user-defined values.

1.1 Solution Methods

Given the data of a power system (cables, transformers, lines, generation and loads, etc.) a power flow program computes (solves) for voltages (voltage magnitude and phase angle) and power flows through lines, cables, transformers, etc.
There are a number of solution techniques that can be used to solve power flow equations. The EASPPF program also incorporates a number of solution methods. Each solution technique has its own merits and disadvantages.
Two popular solution techniques are Gauss-Seidel and Newton Raphson method. The Newton Raphson method itself has a number of variations (Decoupled, Fast Decoupled). The Gauss-Seidel method is slow in convergence but effective for radial (not heavily meshed) power systems. In this method, voltages within first few iterations approach their final values, but it takes quite few iteration to eventually converge to final solution.
On the contrary, the Newton Raphson method is slow to get close to final solution but once near the final solution it requires just a few iteration to arrive at final solution. This suggests that it may be beneficial to start power flow solution with a few Gauss-Seidel iterations and then switch to Newton Raphson method. The EASPPF offers the following solution options:

- Gauss-Seidel;
- Newton Raphson;
- Fast Decoupled
- Newton Raphson.

It is also possible to choose the option of relaxing generator reactive power limits with any of the above solutions. EDSA Advanced Power Flow program also provides an option to start solution with a number user specified iterations of Gauss-Seidel before starting Newton methods

1.2 Choosing A Solution Method

Different solution methods (after it converged) do not offer any advantage over each other in the degree of solution accuracy. In selecting a solution method, the following procedure is suggested:

1) Start with “Newton Raphson - Fast Decoupled” solution technique. Do not try to solve the problem with extremely small solution tolerance
2) If the solution does not converge examine the solution iteration report by choosing “LogInfo”.

EASPPF is capable of handling power systems with multiple islands. Of course if an island to have voltages, it must have at least one active source (generator). At least one of the generators in each island must be assigned as “Swing/Reference” bus. If an island does not have any active source,
the program will set the voltages within that island to zero. If an island does have at least one active source but none of the active sources in that island is assigned as “Swing”, the program will automatically assign one of the active sources to be the “Swing” for that island.

2 Required Data for Performing a Load Flow Study

A significant part of the preparation of a Load Flow Study is represented by single-phase network modeling. This consists of getting the one-line connection diagram, getting the network component impedances and source impedances.

The following data are required:

- Single-phase one-line connection diagram. The diagram should indicate Bus ID, bus voltages (line-to-line, and line-to-neutral), connection type;
- **Transformer Input data:**
  - Transformer short circuit impedance $\%Z$ and X/R ratio, or $\%R$ and $\%X$, or R and X in per unit;
  - Primary voltage line-to-line and line-to-neutral;
  - Secondary voltage line-to-line and line-to-neutral;
  - Transformer KVA.
- **Cable Input Data:**
  - Cable size and type;
  - Cable length;
  - Cable R and X per unit length, or in per unit;
  - Duct type;
- **Motor Input Data:**
  - Motor ratings (Amps or KVA, or HP, and %Efficiency and %Power Factor);
  - Motor line-to-neutral rated voltage;
  - % sub transient reactance (equals to Motor Full Load Current divided by Motor Locked Rotor current times 100) and X/r ratio, or R and X in per unit;
  - number of poles;
- **Generator Input Data:**
  - Generator rating in KVA;
  - % subtransient reactance and X/R ratio or R and X in per unit;
  - Generator nameplate voltage, line-to-neutral.
- **Utility Input Data:**
  - Fault contribution in KVA and X/R ratio;
  - Utility rated voltage, line-to-line, or line-to-neutral.

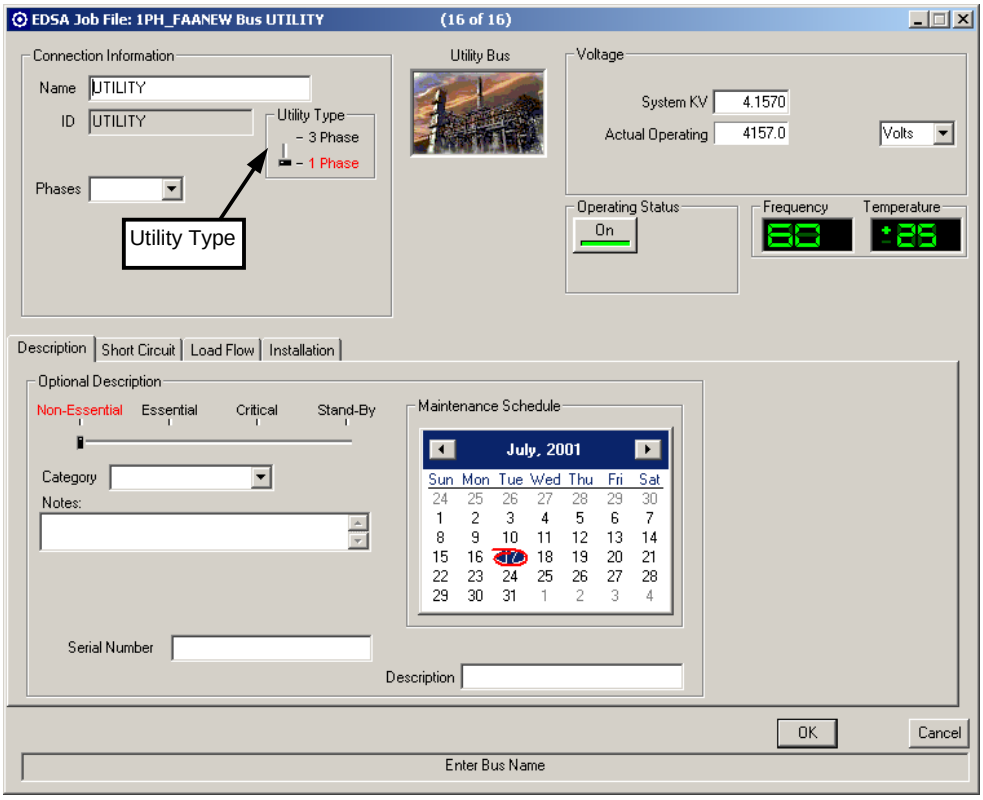
2.1 Advanced Single -Phase Power Flow Program Dialog Windows

Start the EDSAT2K program and either select a new file or open and existing file.

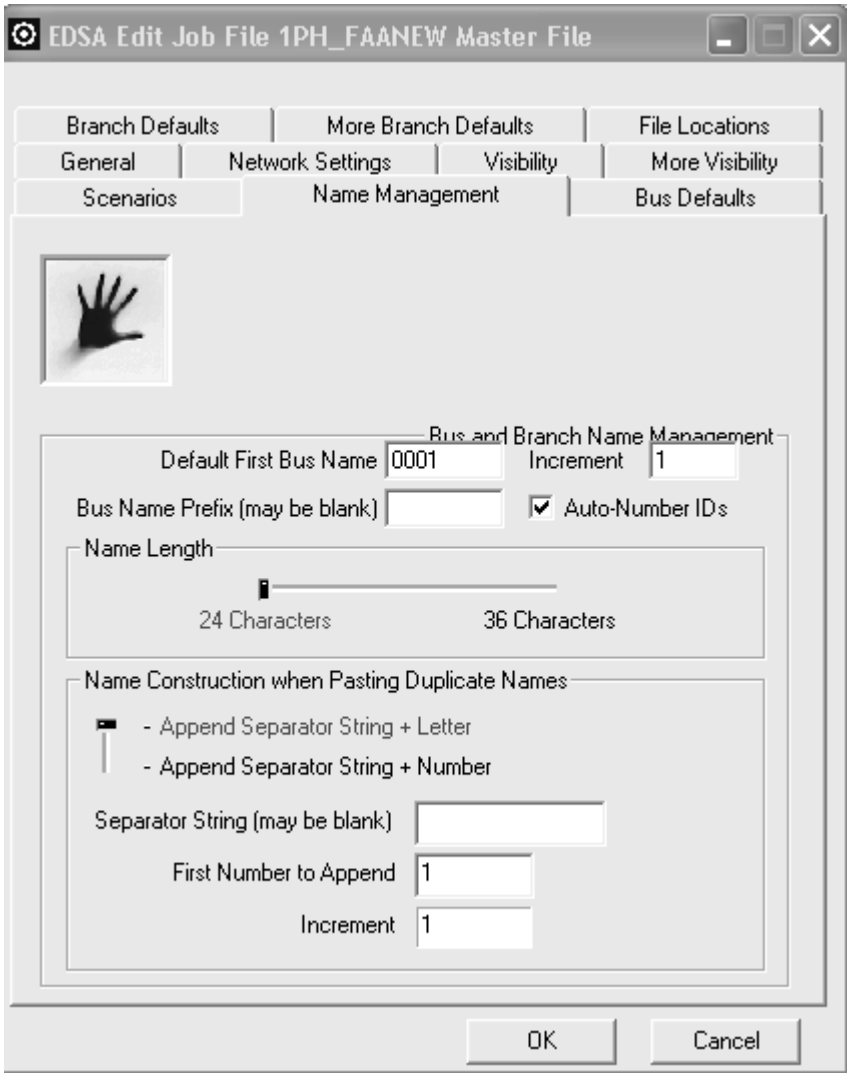
Check the EDSA Master File Editor; the user should be in the AC 1 Phase network type. While in the AC 1 Phase Network, the single-phase catalog will be automatically opened.

The followings are the symbol Dialog Windows, the user works with:

2.2 Utility Dialog Window:



Utility Connection Information: Bus name and utility type the user needs to introduce. The user can input up to 24 or 36 characters for the Bus name, as it has been selected by the user in the EDSA Master File Editor – Name management (see the picture below):



Bus Name management:

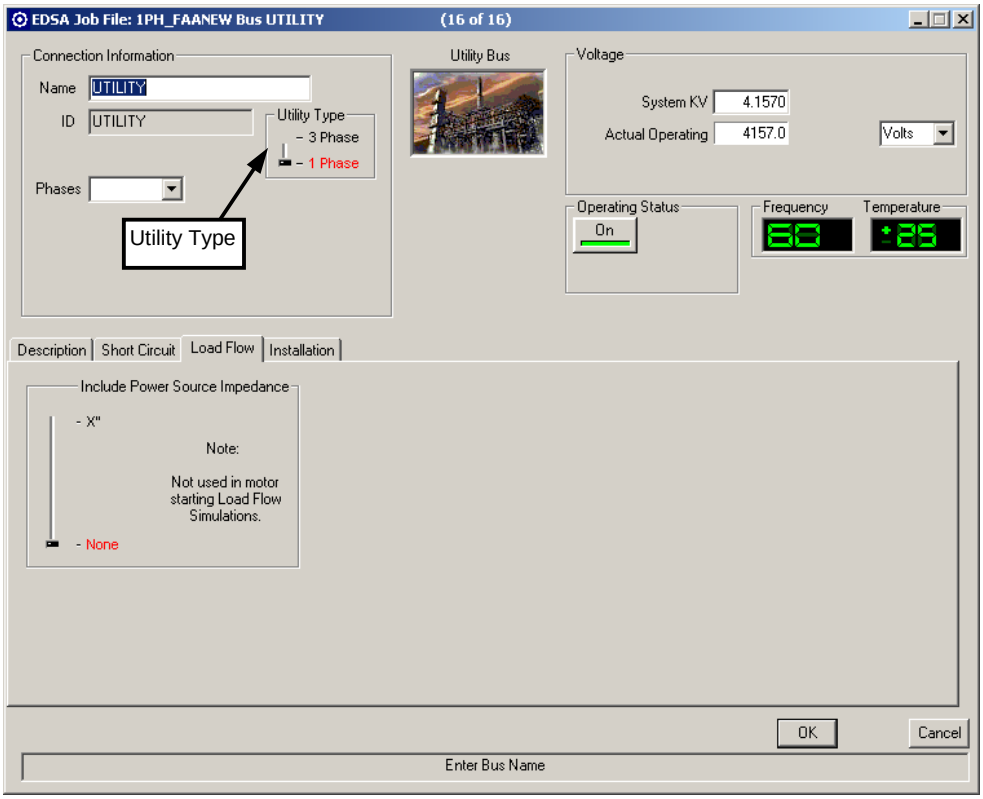
Utility Type: this is the type of the connection network point. To this point the single-phase network is connected to the Utility. The connection network point may be:

- 3-phase network type;
- 1-phase network type.

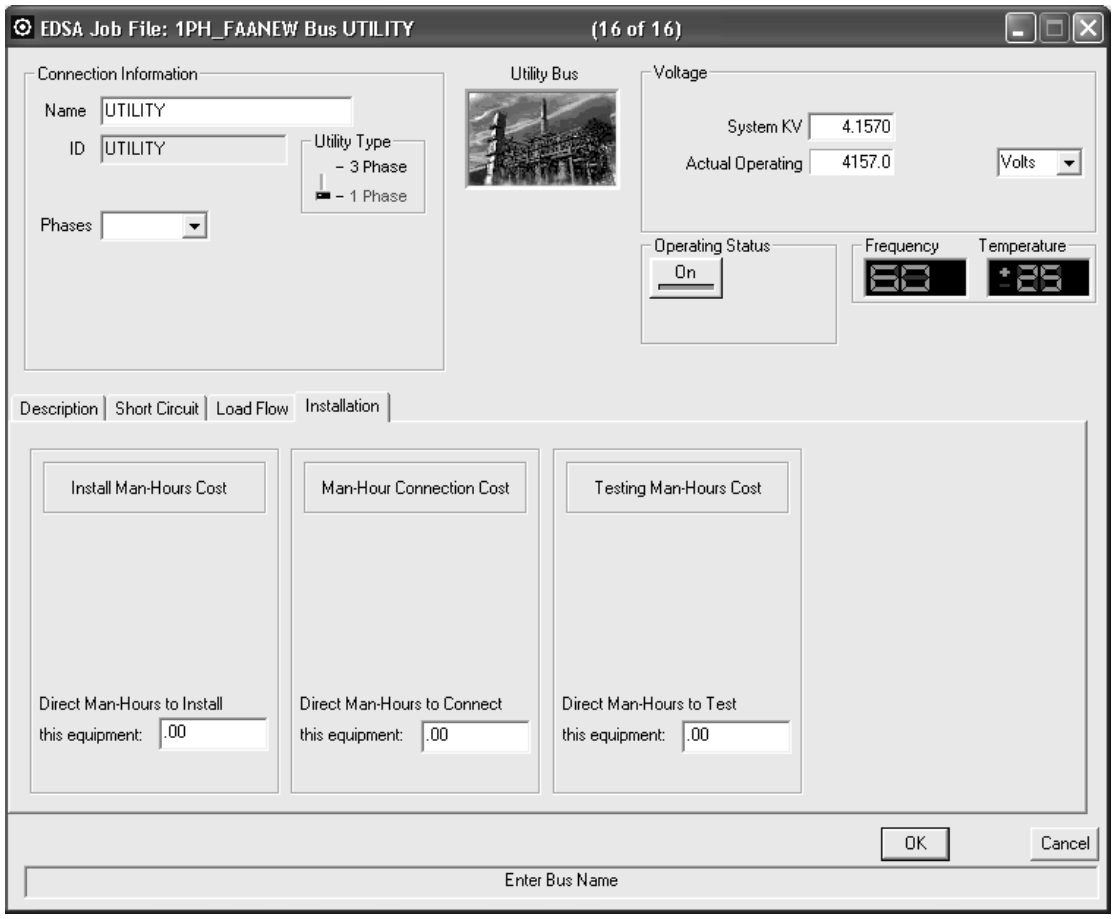
Utility System Voltage:
If the Utility type is 1-phase network, the line-to-line voltage is given;
If the Utility type is a 3-phase network, both the line-to-line and line-to-neutral voltages are given, in either volts or KV or in per unit.

Utility Short Circuit Information Tab:
Provides the Utility fault contribution to the connection point. It is given in KVA, MVA, Amps or in per unit.

Utility Load Flow Tab:
Provides the Utility Actual Operating Voltage, Utility Type (3 phase or 1Phase), Utility Status (ON or OFF). The Load Flow may or may not include the power Source Impedance.



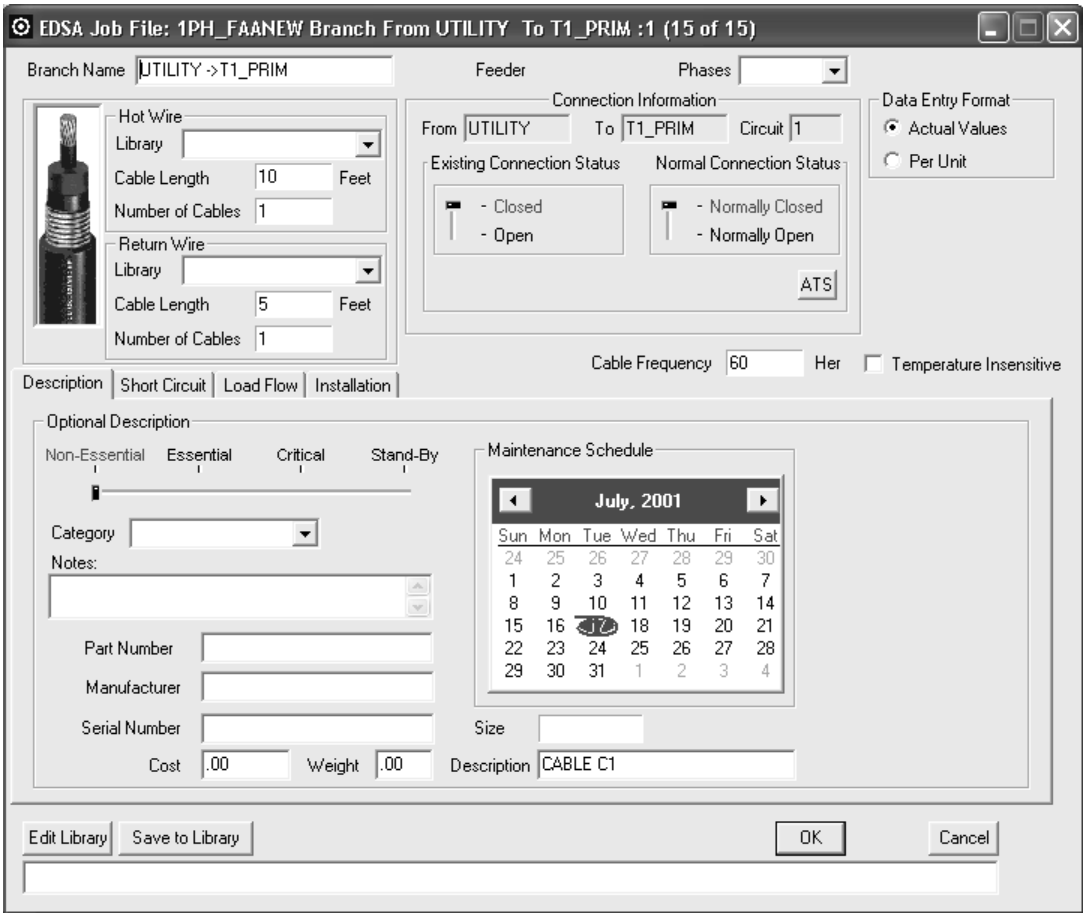
Include Power Source Impedance: This option allows the user to include or not the power source impedance.



Utility Installation Tab:
Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. This information is for document purposes, and however these fields can be left blank.

2.3 Feeder Dialog Window

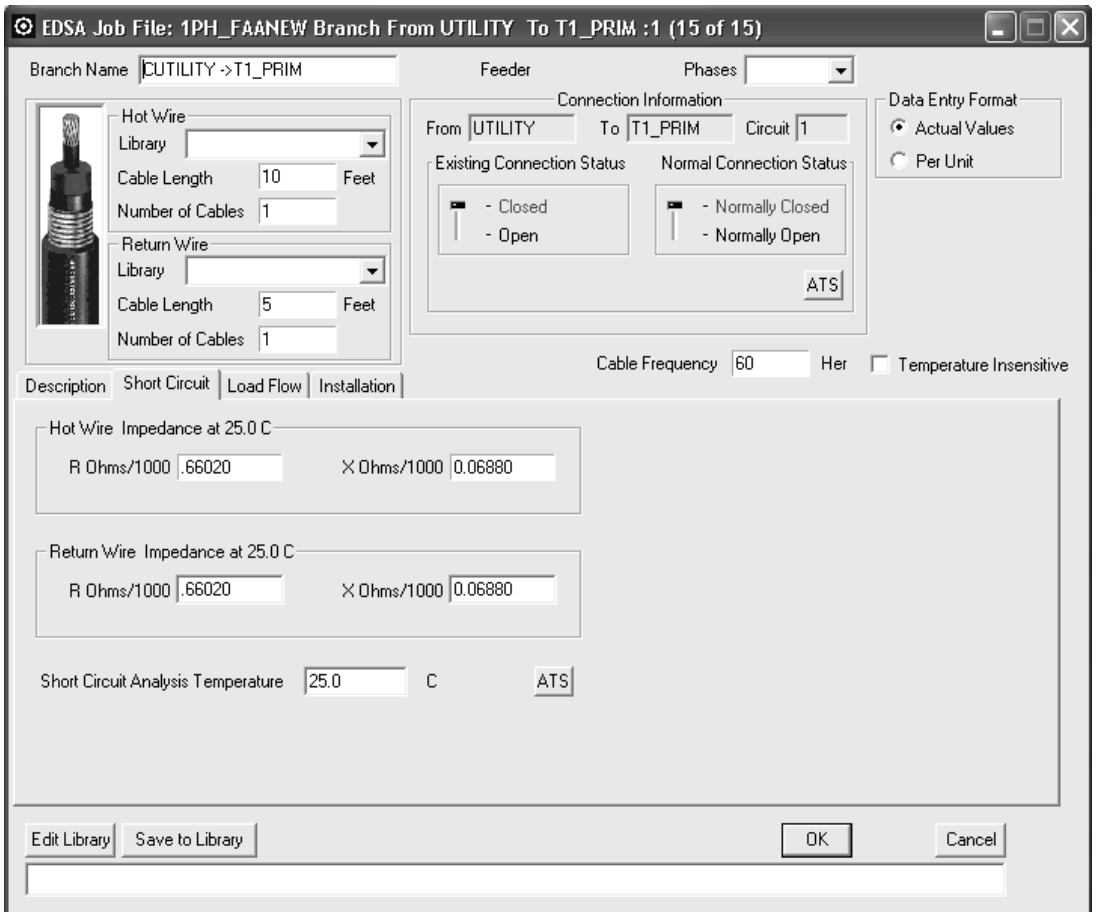
As the network is a single-phase network, both the phase/hot and return feeder information are required. Type, length, R and X of each feeder section need to be input. The hot and return feeder input data are provided separately. However, these data may be different, and they should be provided by the EDSA user:



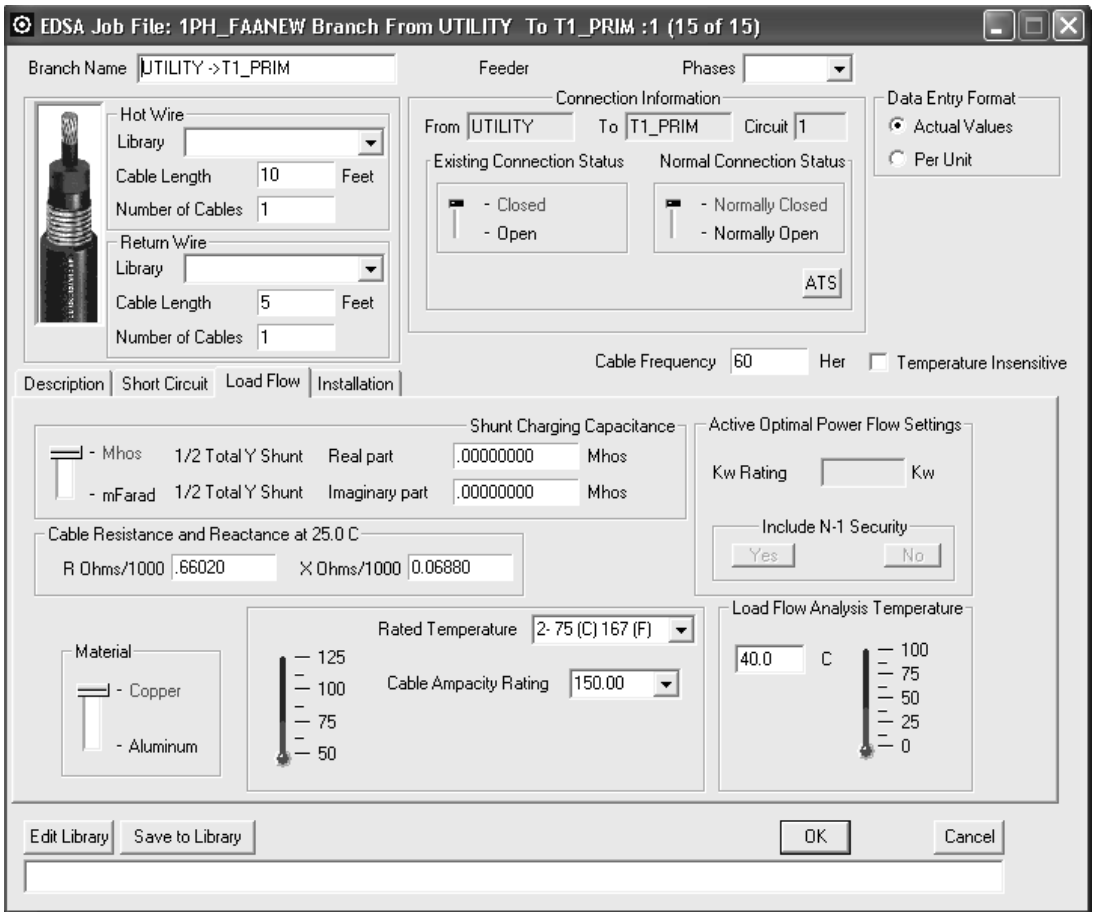
The feeder dialog windows has four tabs:

- Description tab;
- Short circuit tab.;
- Load Flow tab.;
- Installation tab.

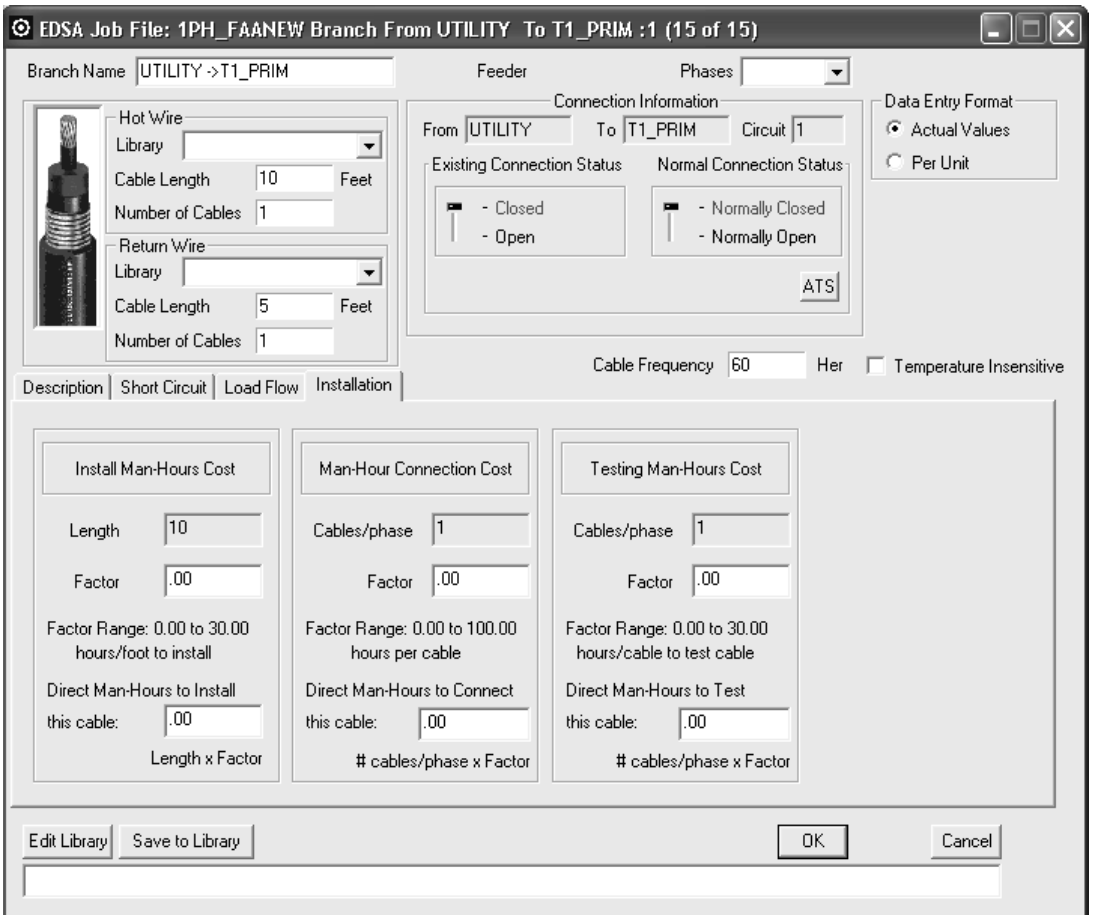
Description tab is for document purposes, and the fields could be left blank.



The short circuit tab: both the hot wire impedance and the return wire impedance has to be introduced by the user at the selected short circuit analysis temperature.



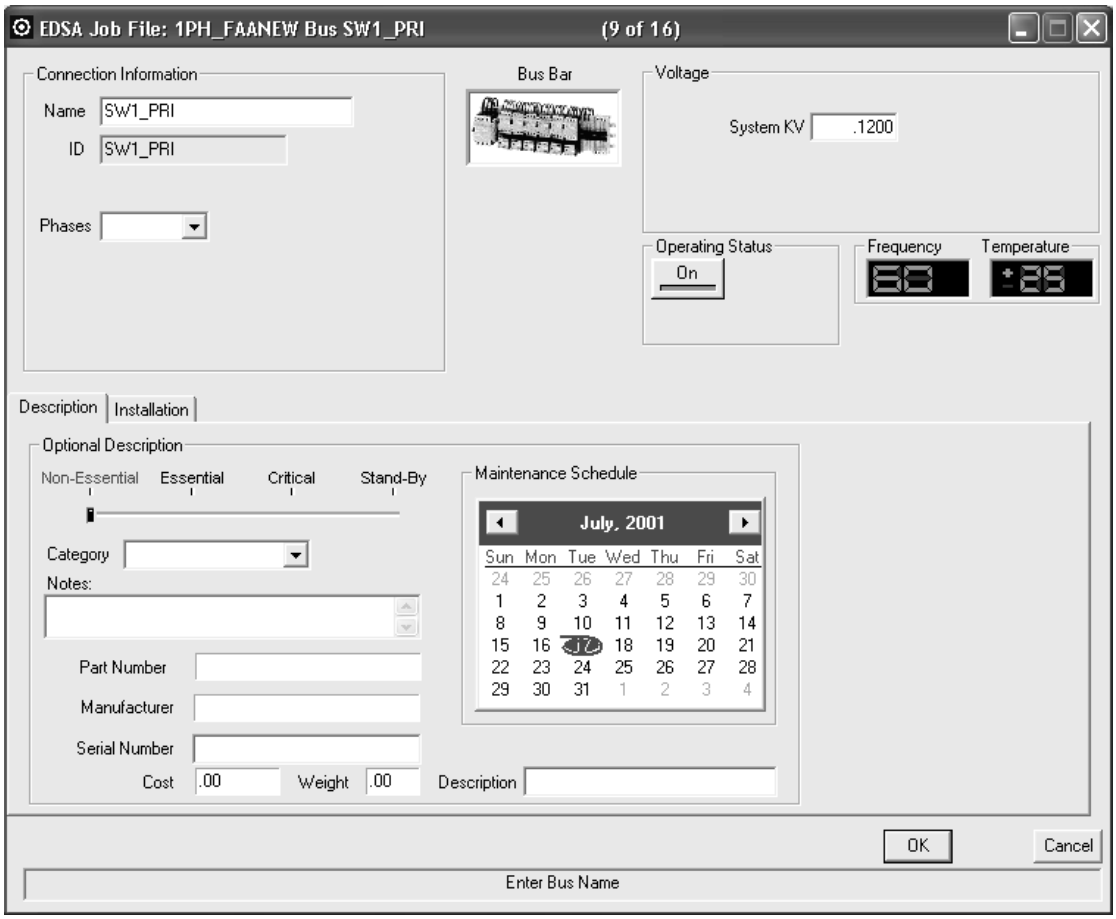
Load Flow Tab.: if requested the feeder shunt parameters can be entered, either in Mhos or MFarad.
Feeder material, resistance and reactance are also displayed. Rated temperature, and Cable Ampacity are also selected here by the user. Load Flow Analysis temperature is displayed.



Feeder Installation Tab:
Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. This information is for document purposes, and however these fields can be left blank.

2.4 Bus Dialog Window

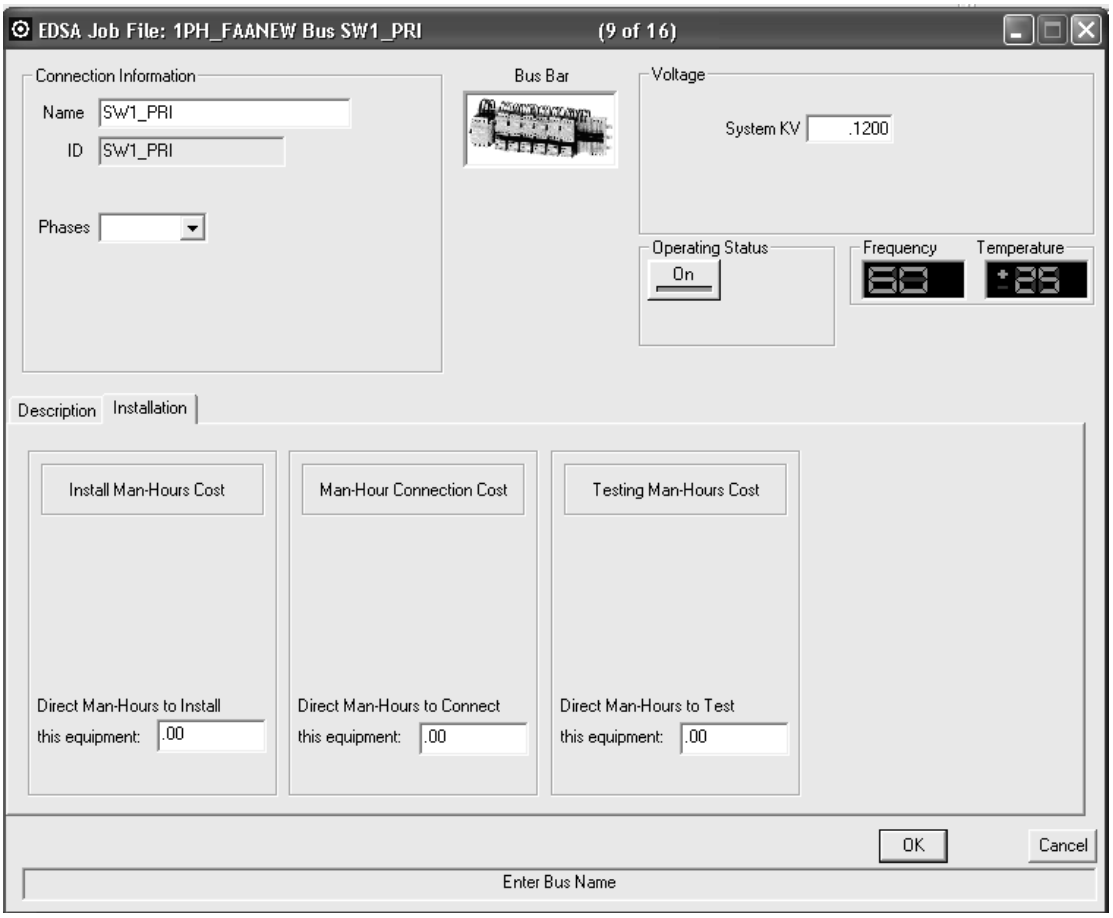
The bus voltage magnitude depends on the way the single-phase network is connected to the utility. If the single-phase network is connected L-L to the Utility, then the bus L-L voltage is displayed, otherwise the L-N voltage is displayed.



There are two tabs:

- Description tab;
- Installation tab.

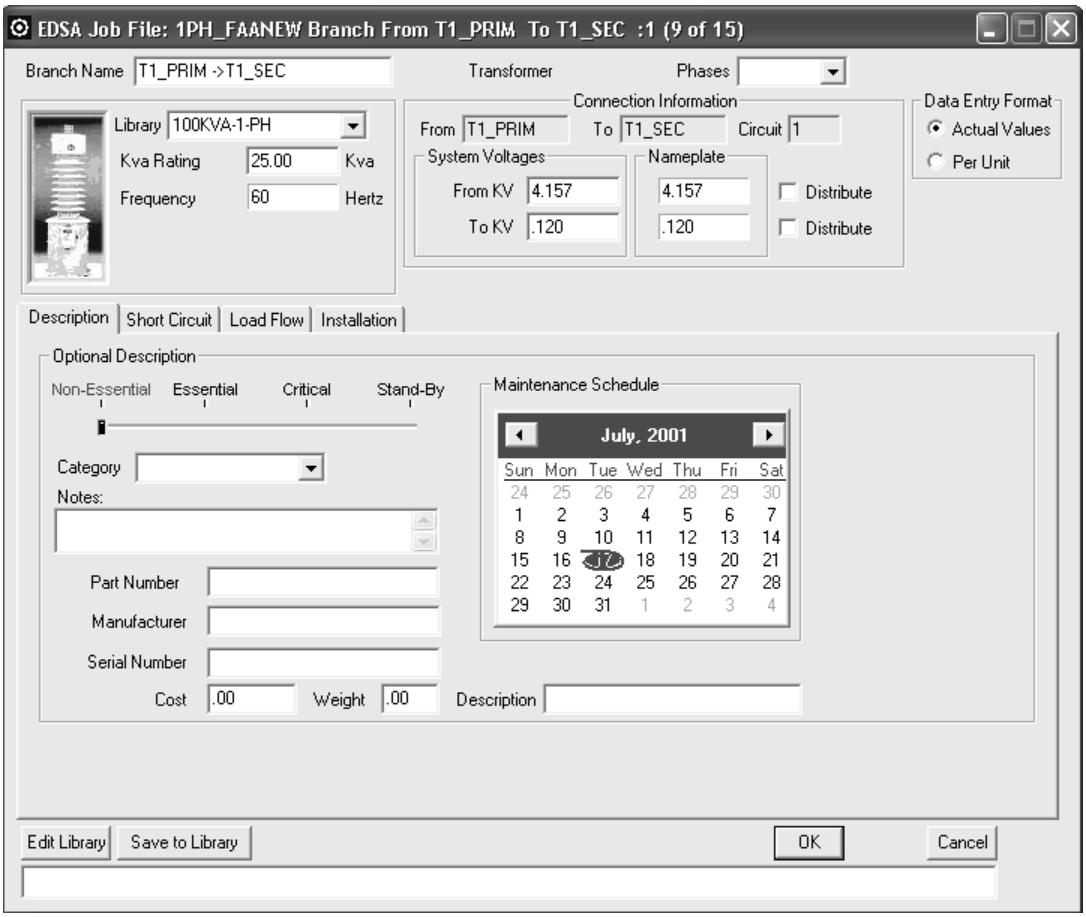
Description tab is for document purposes, and the fields cab be left blank.



Installation tab.: Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. This information is for document purposes, and however these fields can be left blank.

2.5 Power Transformer Dialog Window

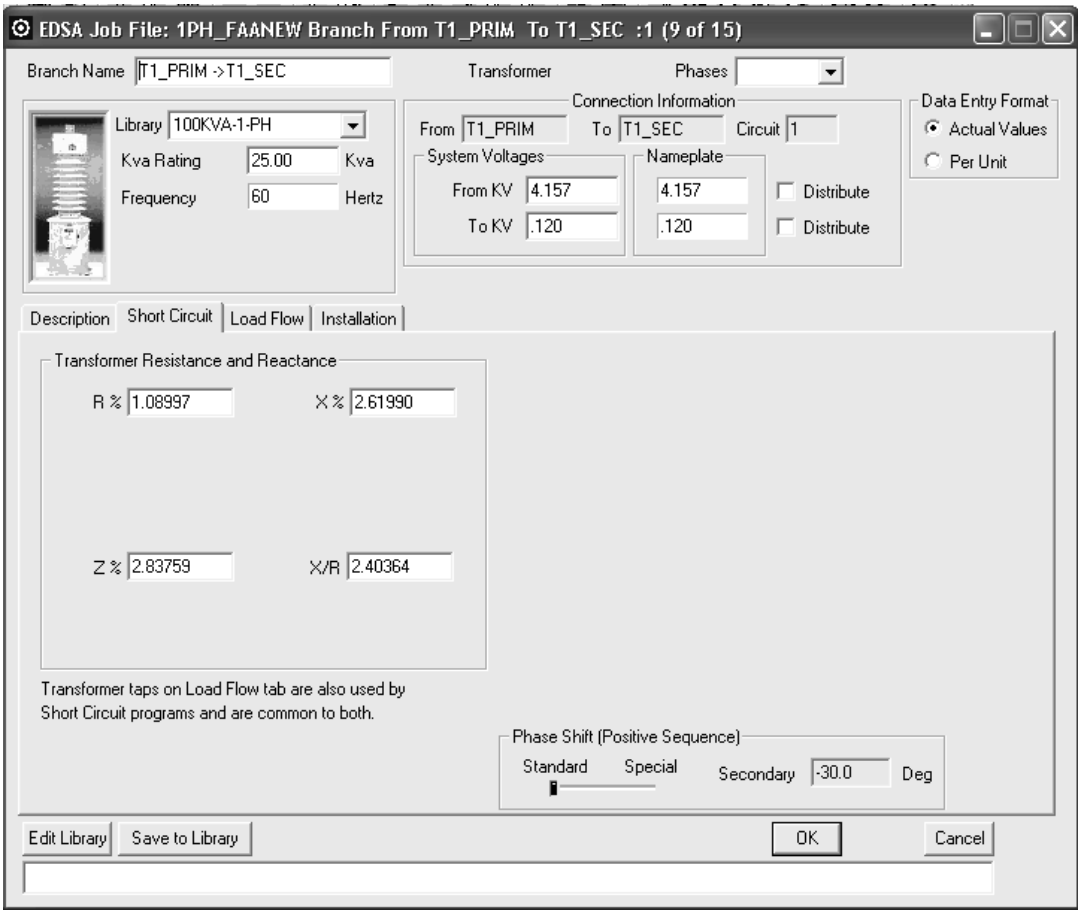
Always the system voltage is L-L regardless the way the single-phase network is connected to the utility.



The power transformer dialog window has 4 tabs:

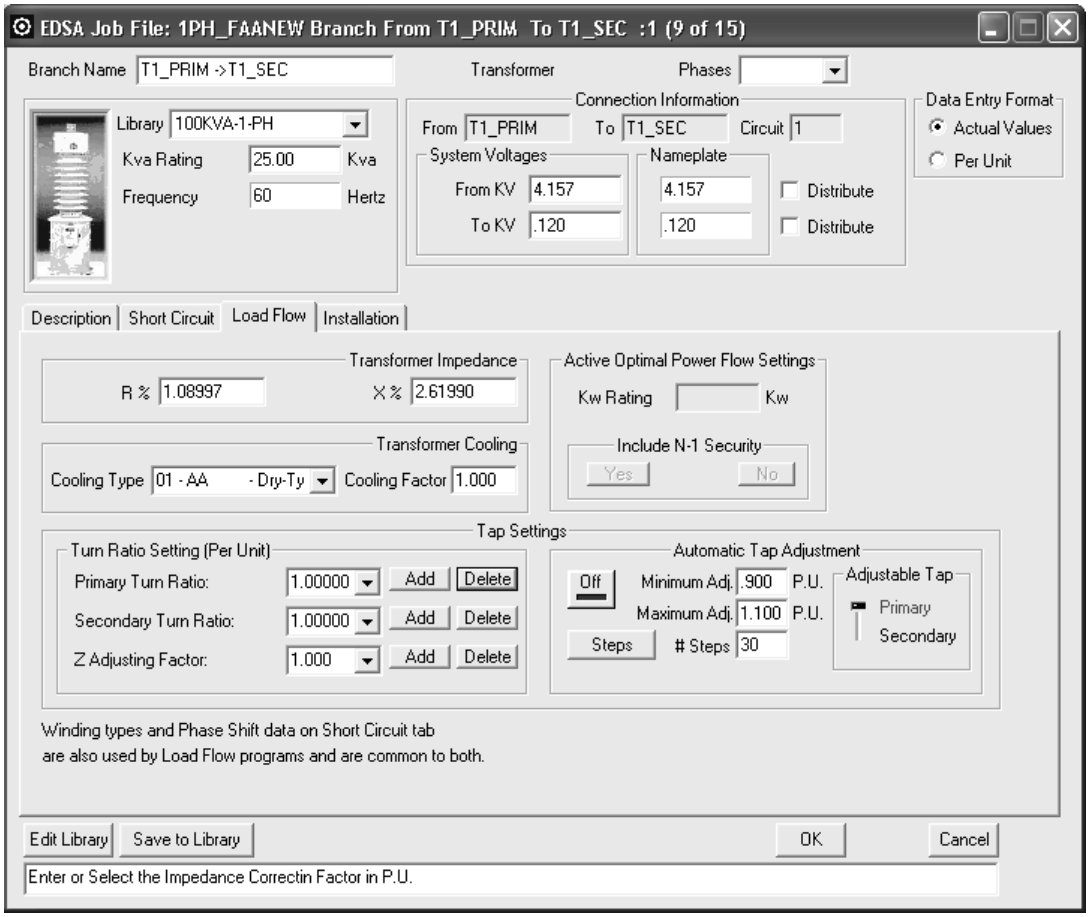
- Transformer description;
- Transformer short circuit input data;
- Transformer load flow input data;
- Transformer installation tab.

Transformer description fields are for document purposes, and they can be left blank.



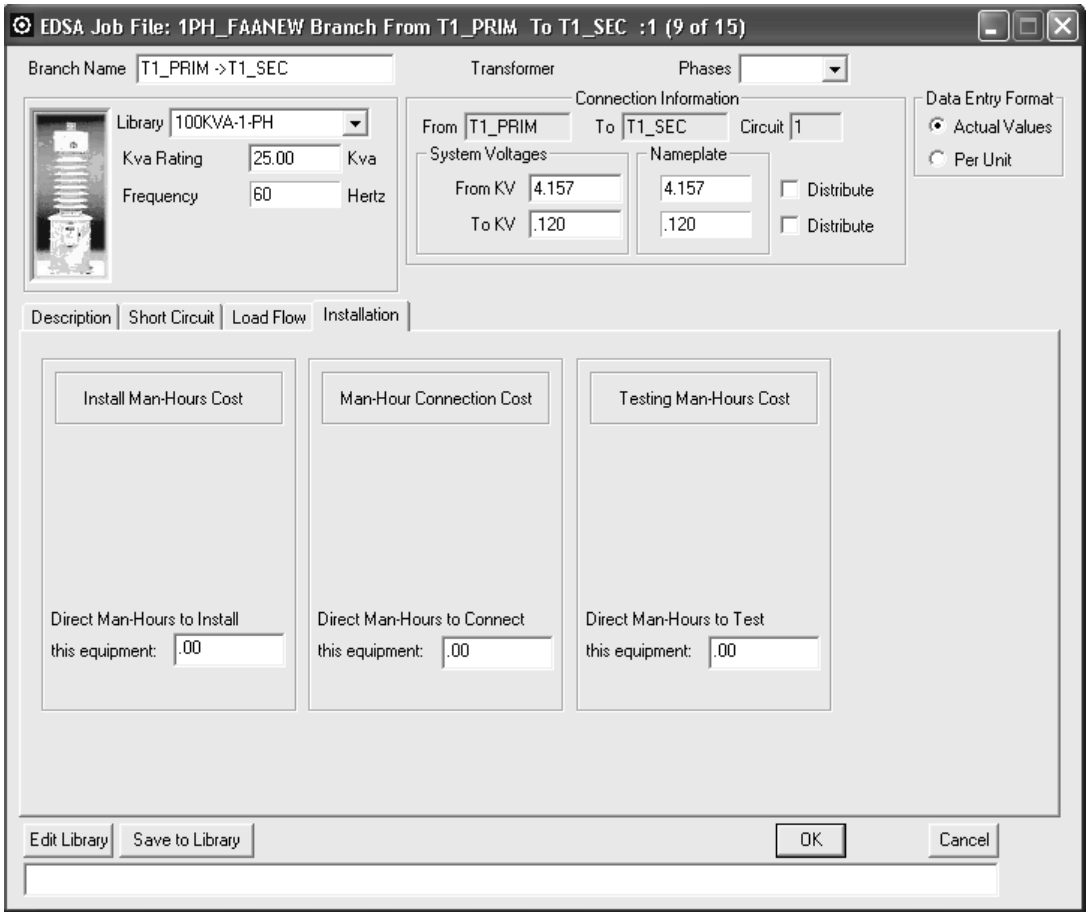
The transformer short circuit tab requires:

Either transformer R% and X%, or Z% and X/R ratio. Transformer phase shift on the secondary side and the network phase.



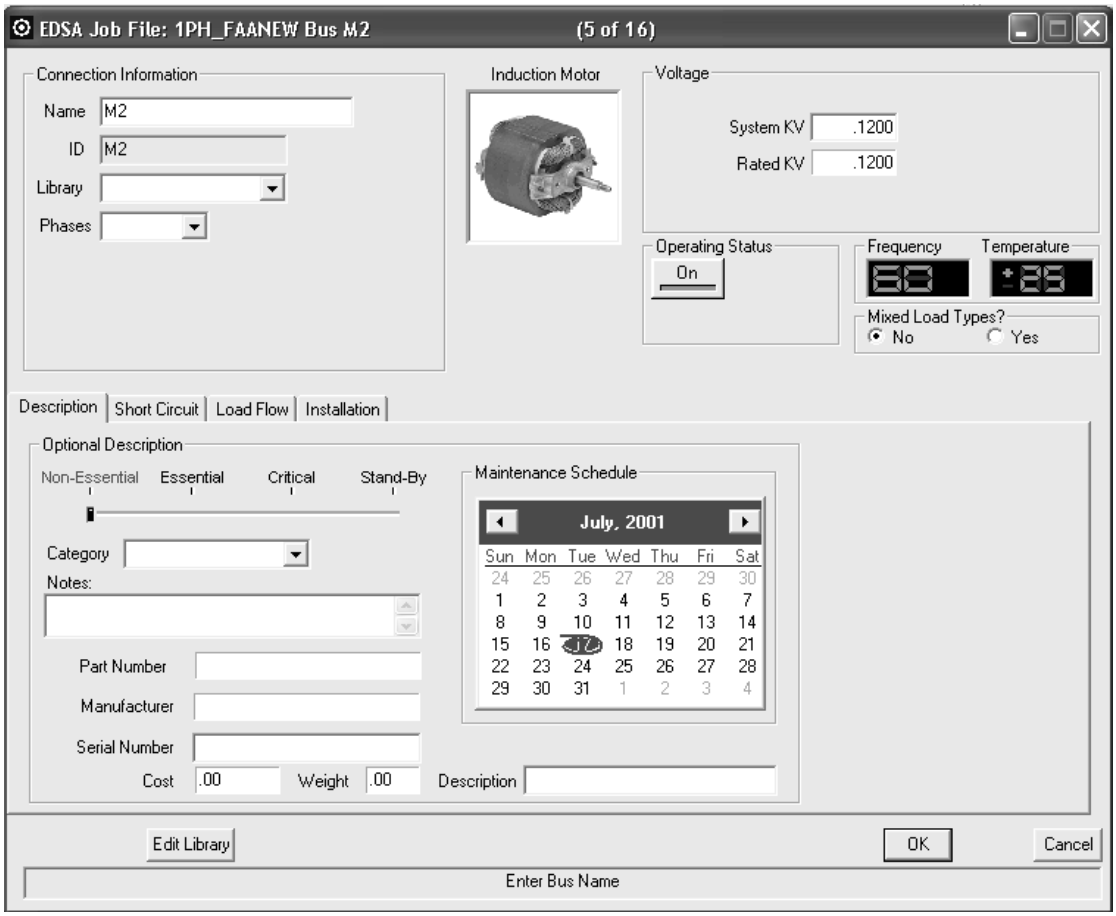
Power Transformer Load Flow Tab, requires:

- Transformer cooling type;
- Turn ratio settings;
- Automatic tap adjustment (if this exist).



Installation tab.: Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. These fields can be left blank.

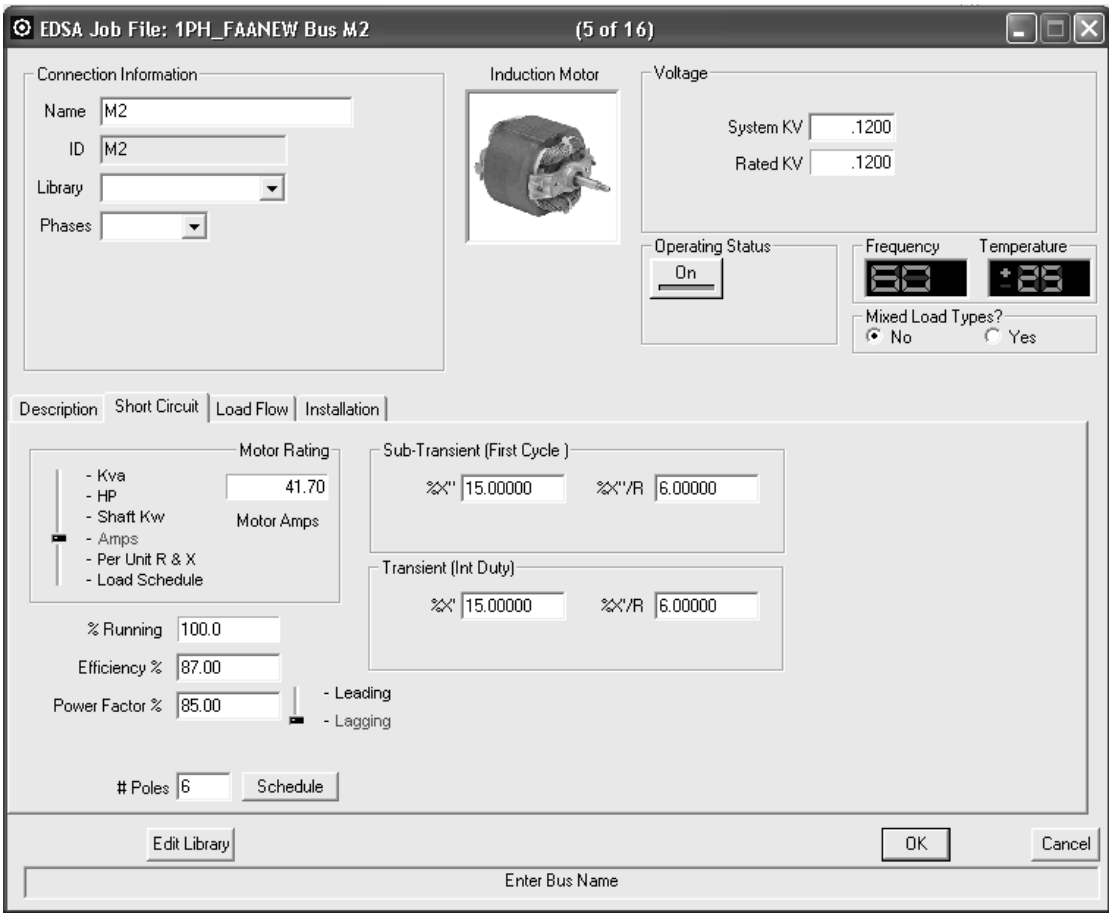
2.6 Motor Dialog Window



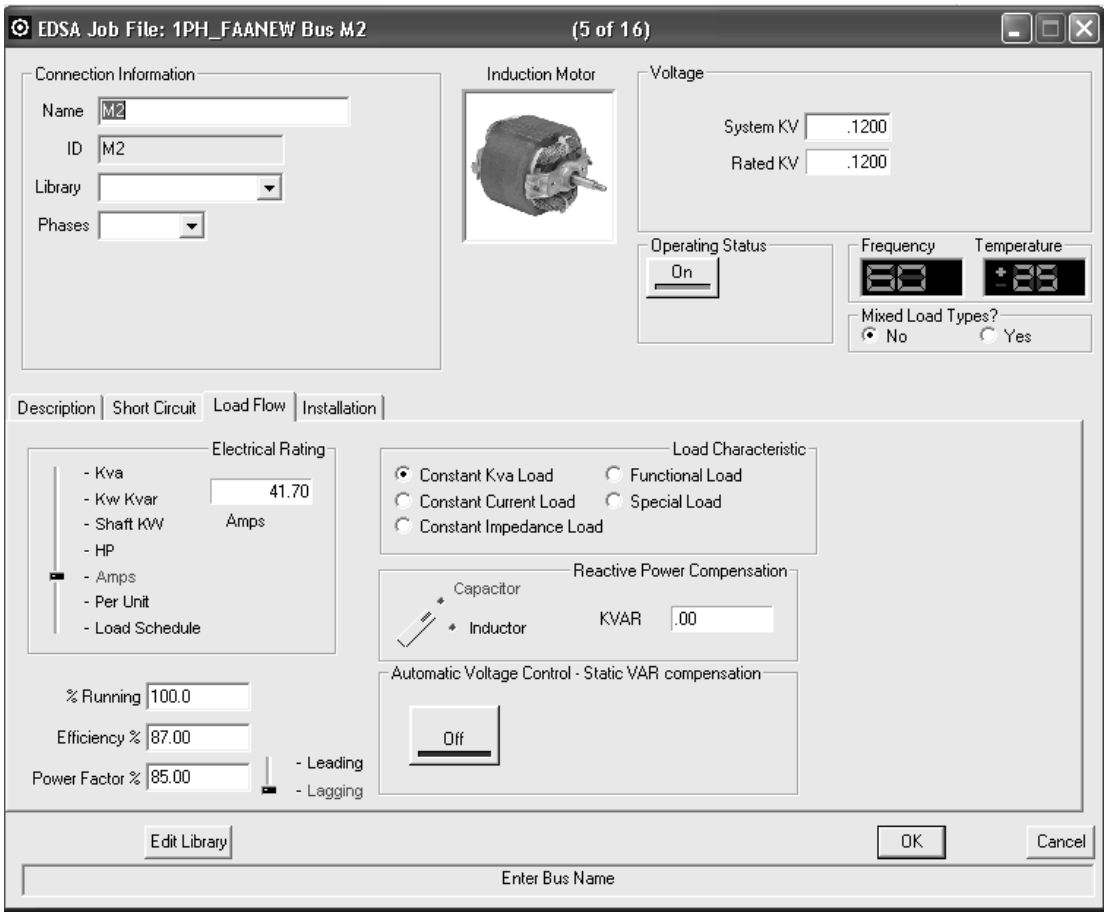
The motor dialog window has 4 tabs:

- Motor description;
- Motor short circuit input data;
- Motor load flow input data;
- Motor installation.

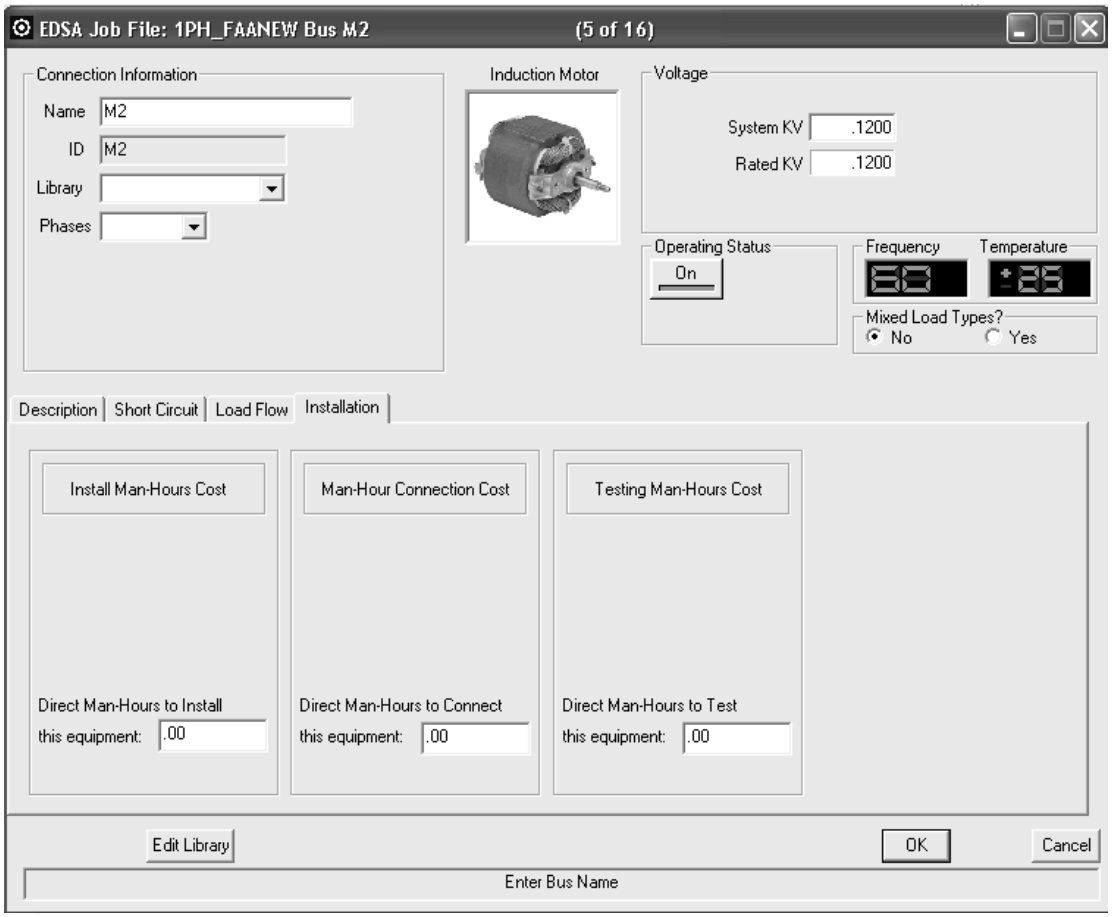
Motor description fields are for document purpose.



The Motor short circuit input data tab requires:
Motor ratings (Motor Rated Power, %Running, %Power Factor, %Efficiency), subtransient and transient reactance, and X/R ratio.

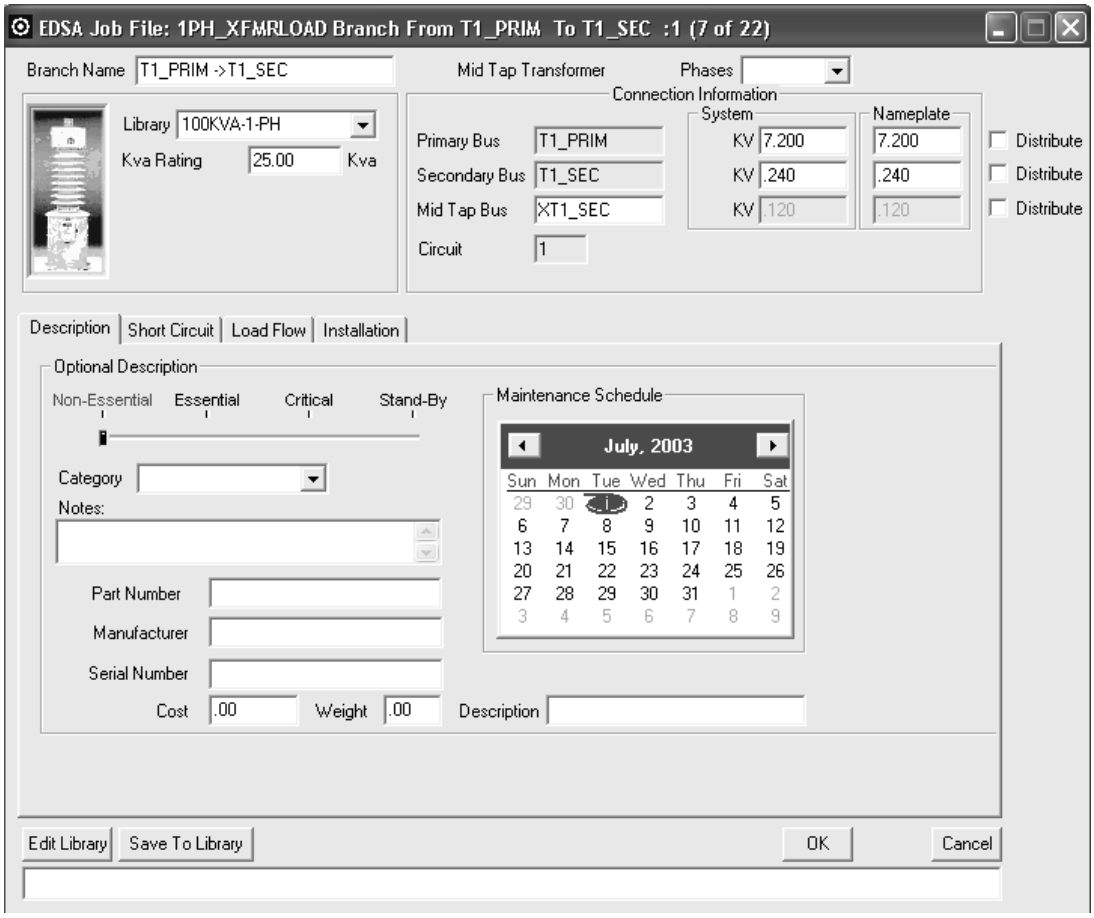


The Motor Load Flow Tab requires:
Load characteristics and local reactive compensation (if this exists). An automatic Voltage Control – Static VAR compensation may be included at this bus.



Installation tab.: Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. These fields can be left blank.

2.7 Mid Tap power transformer dialog window



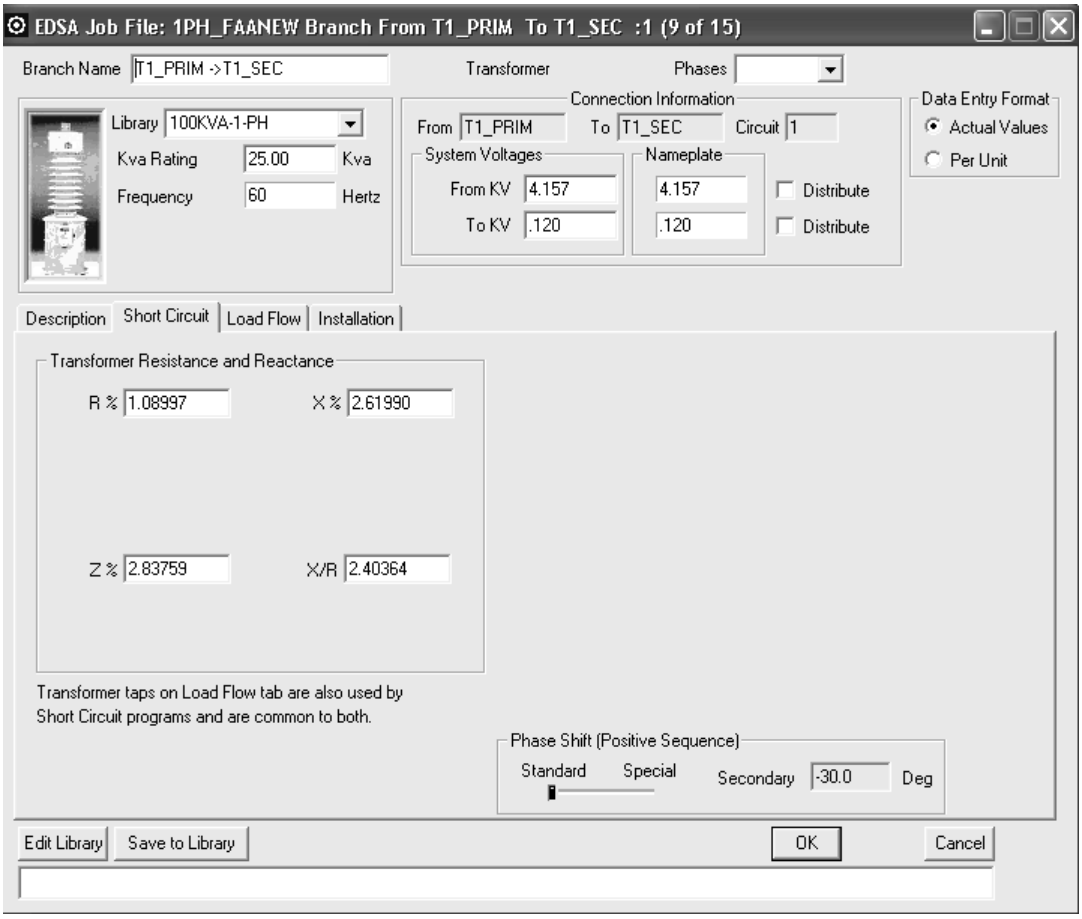
Mid Tap power transformer is used to connect a single-phase network to a three-phase network, either L-L or L-N connection.

The mid tap power transformer dialog window has 4 tabs:

- Transformer description;
- Transformer short circuit input data;
- Transformer load flow input data;
- Transformer installation.

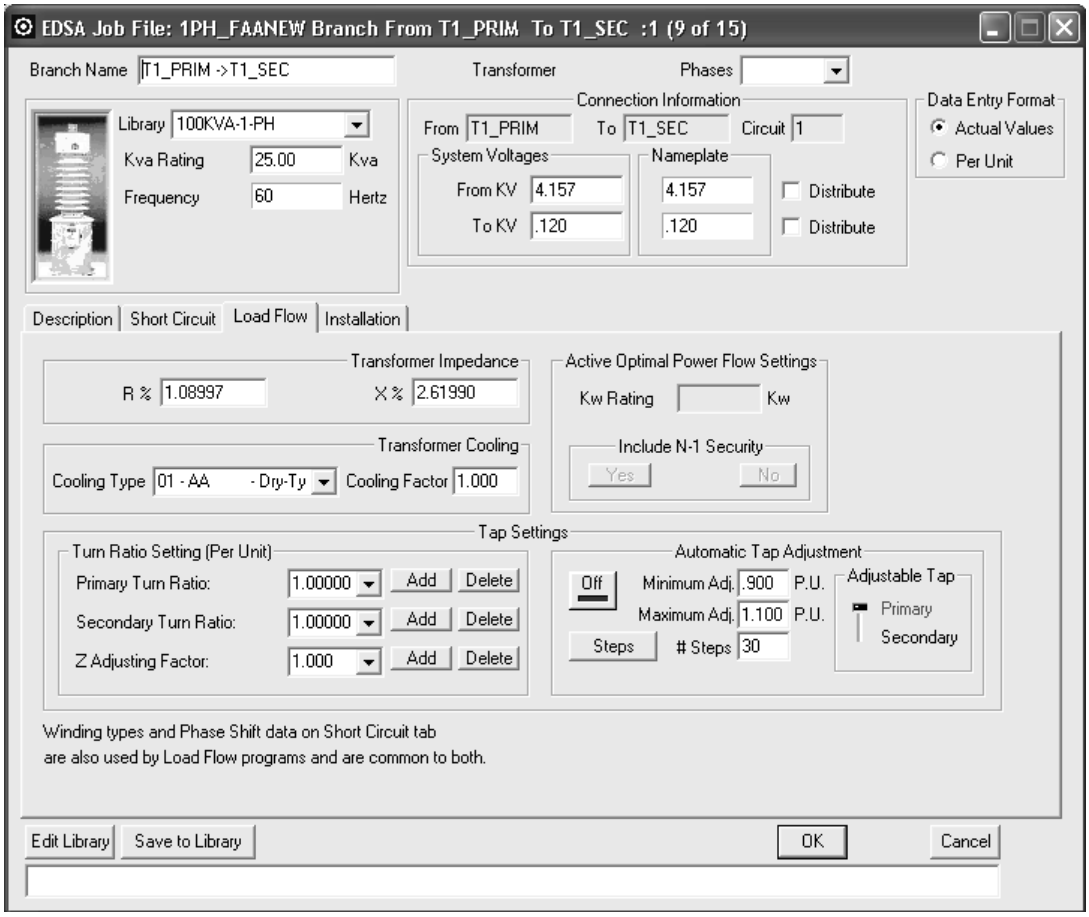
Transformer description fields are for document purpose, and are presented above.
The connection information provides the:

- system primary bus voltage;
- system secondary bus voltage;
- mid tap bus voltage; it is automatically calculated by the program ($U_{mid\_tap} = \frac{U_{\sec Bus}}{\sqrt{3}}$)
- transformer primary terminal/nameplate voltage;
- transformer secondary terminal/nameplate voltage;



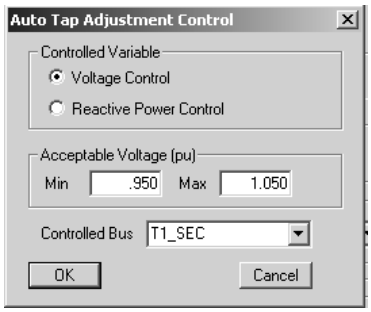
The transformer short circuit input data tab requires:

- Transformer %Z and X/R ratio;
- Half/Full impedance ratio for transformer resistance, MF(R) (usually 1.4 to 1.5);
- Half/Full impedance ratio for transformer reactance MF (X)(usually 1.1 to 1.2);



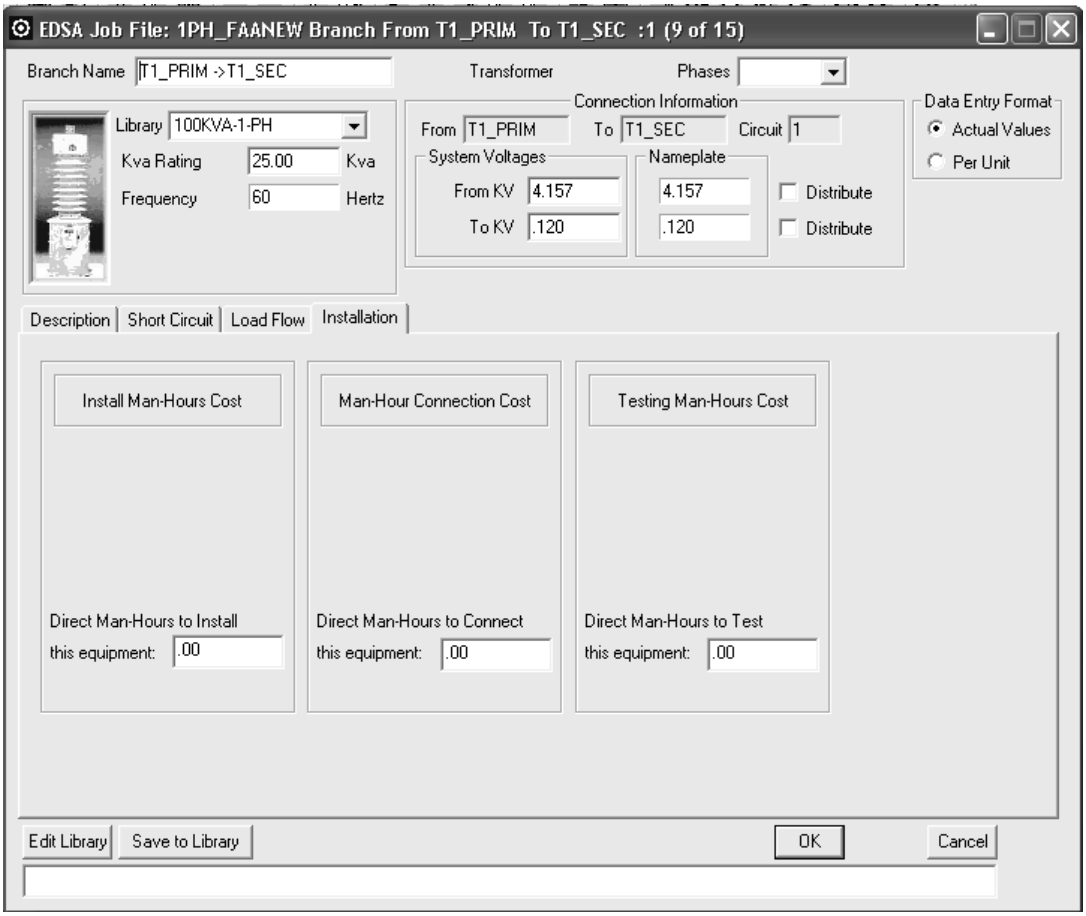
The transformer Load Flow input data tab with the following fields:

- %R and %X, same as for the short circuit tab;
- Cooling type, which automatically gives the cooling factor / transformer loading factor;
- Transformer tap settings:
  - Primary and secondary turn ratio, in per unit;
  - Z adjusting factor;
  - Automatic tap adjustment, with:
    - Minimum and maximum bus voltage, in per unit;
    - Adjustable tap position, on primary or secondary side;
    - Number of steps controlling the voltage output;
    - Controlled bus;



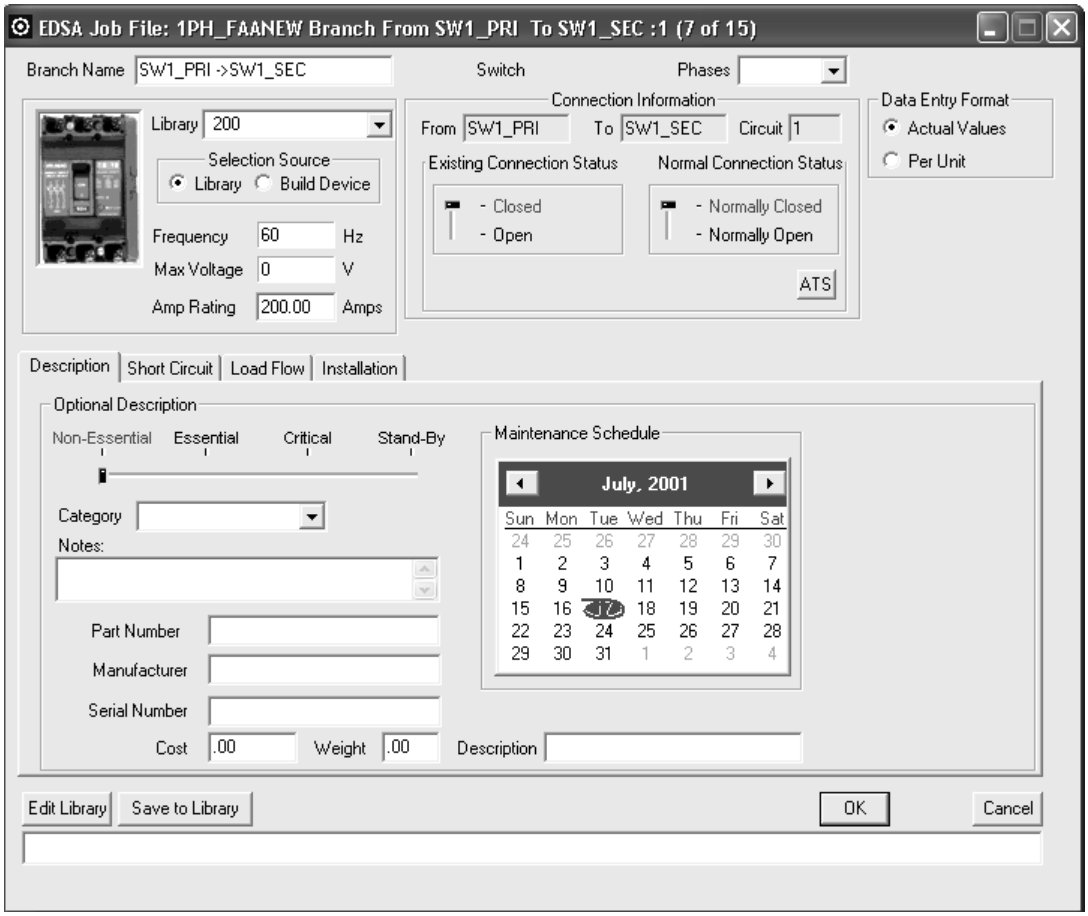
Controlled bus, with:

- Control modes, voltage or reactive power control;
- Bus controlled voltage range, as Min and Max voltage magnitude in per unit;



Installation tab.: Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. These fields can be left blank.

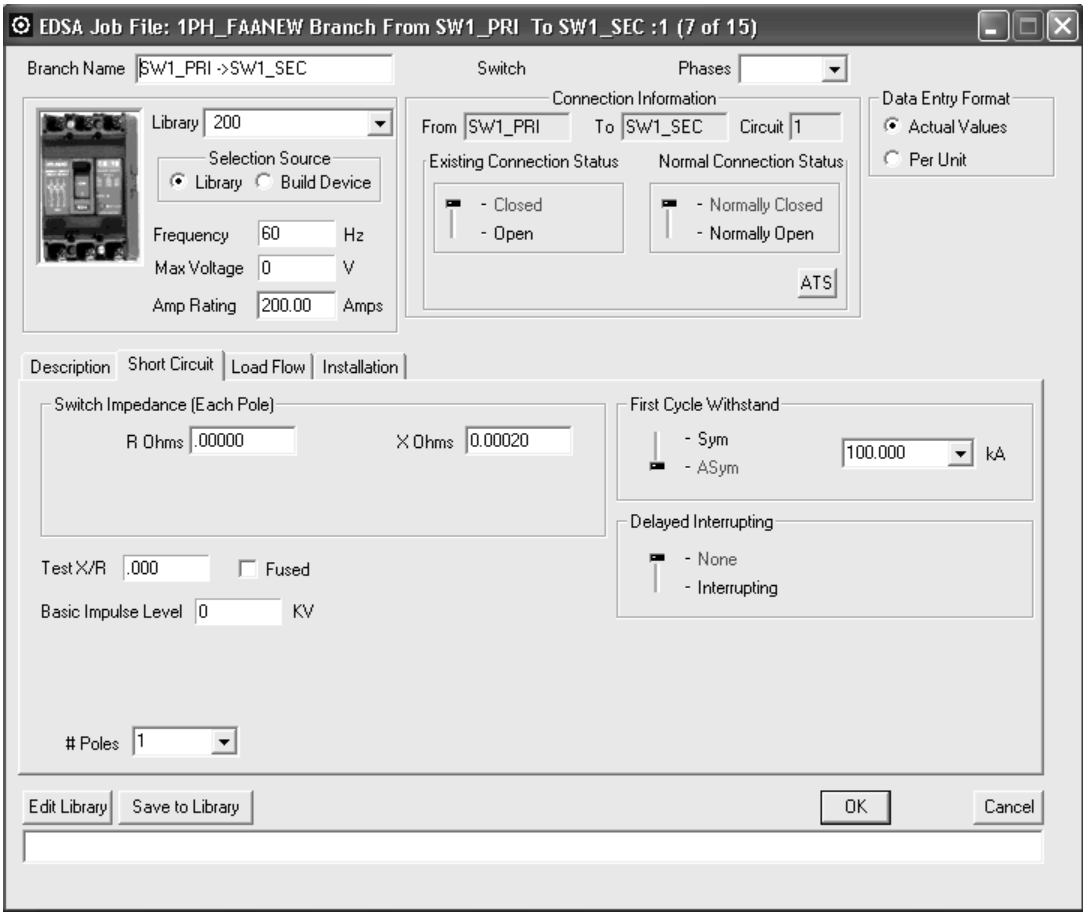
2.8 Single –Phase Switch Dialog Window



The switch dialog window has four tabs:

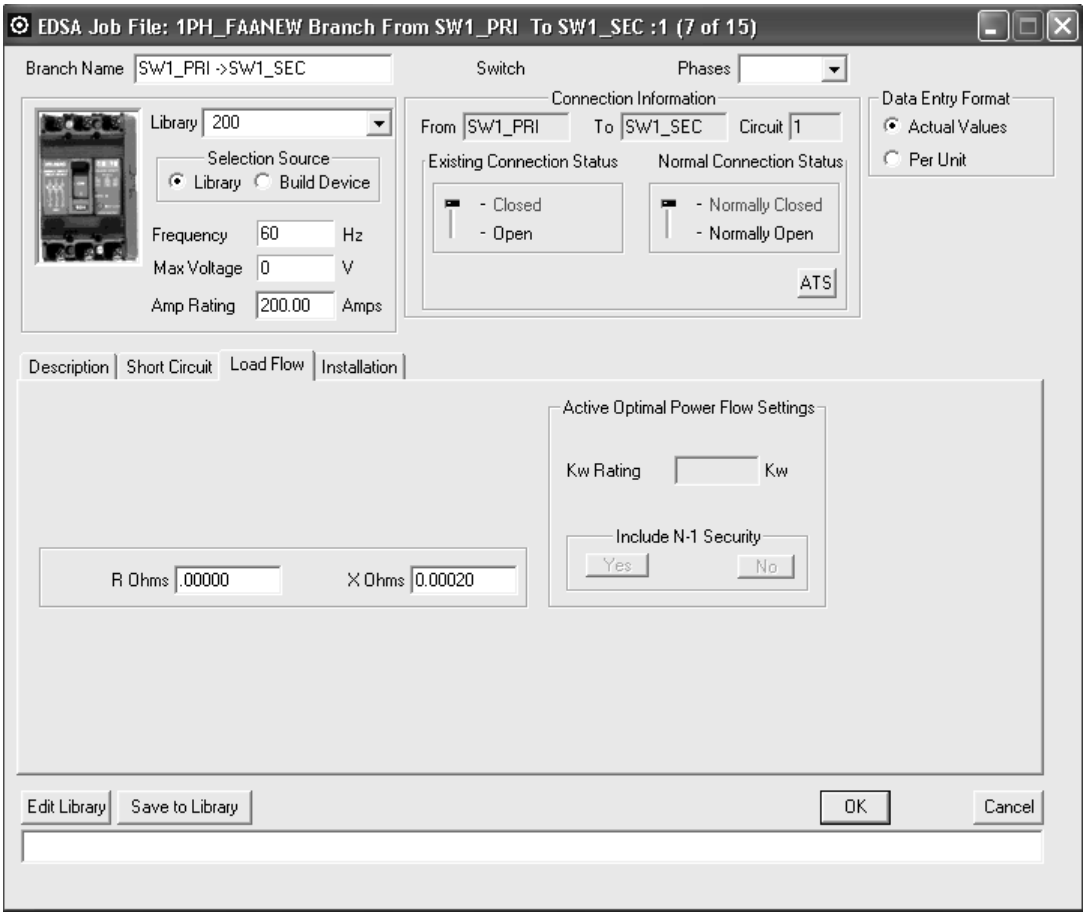
- Description;
- Short circuit;
- Load Flow;
- Installation.

The Switch general input data provides the Switch type, connection information, and switch connection status (open or closed). Switch ratings, in terms of Maximum Voltage and Amp rating.
The descriptions tabs are for document purposes.

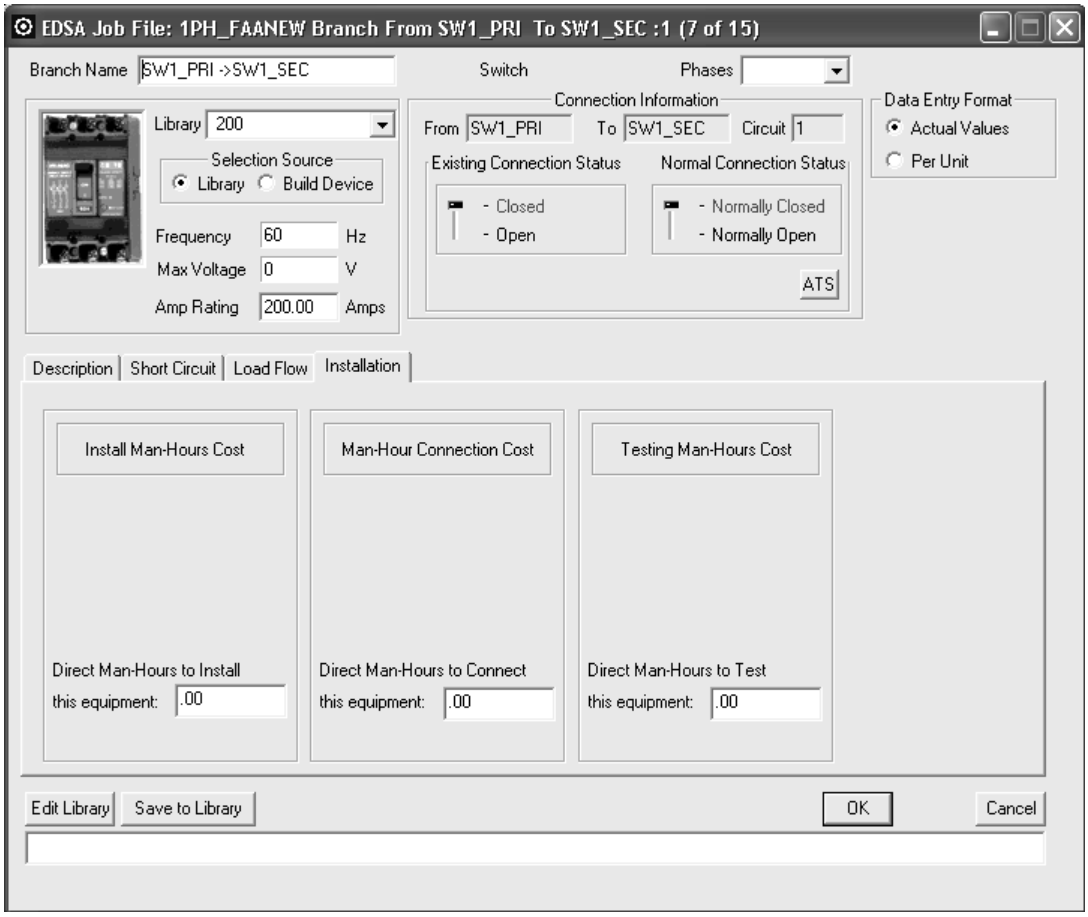


The Switch Short Circuit input data requires:

- Switch R and X, for each pole, in ohms;
- Test X/R ratio;
- Fused or unfused switch;
- Basic impulse level;
- Number of poles (1 or 2);
- Switch interrupting capabilities:
  - Symmetrical;
  - Asymmetrical.
- Delayed interrupting:



The Switch Load Flow input data provides R and X, the same as in the short circuit input data.



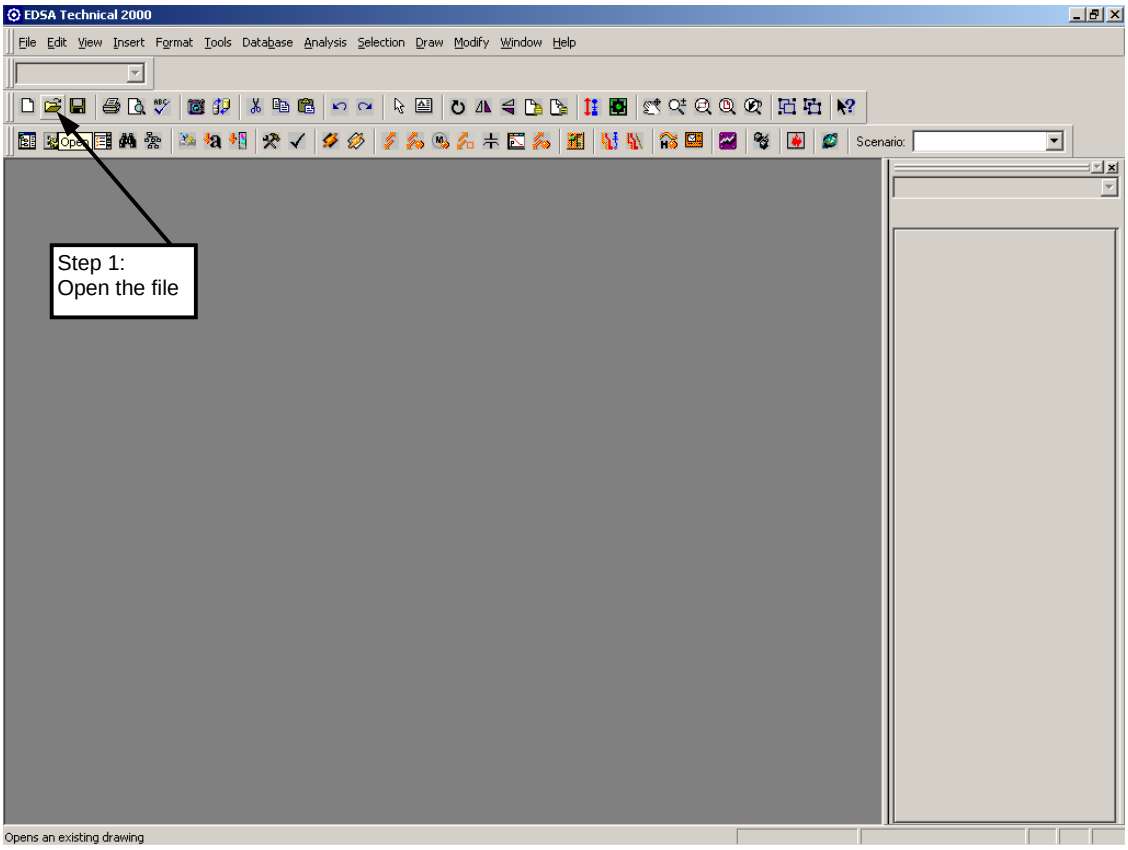
Installation tab.: Provides information on Installation Man-Hours Cost, Man-Hours Connection Cost and Testing Man-Hours Cost. These fields can be left blank.

3 Advanced Single Phase Power Flow Tutorial:

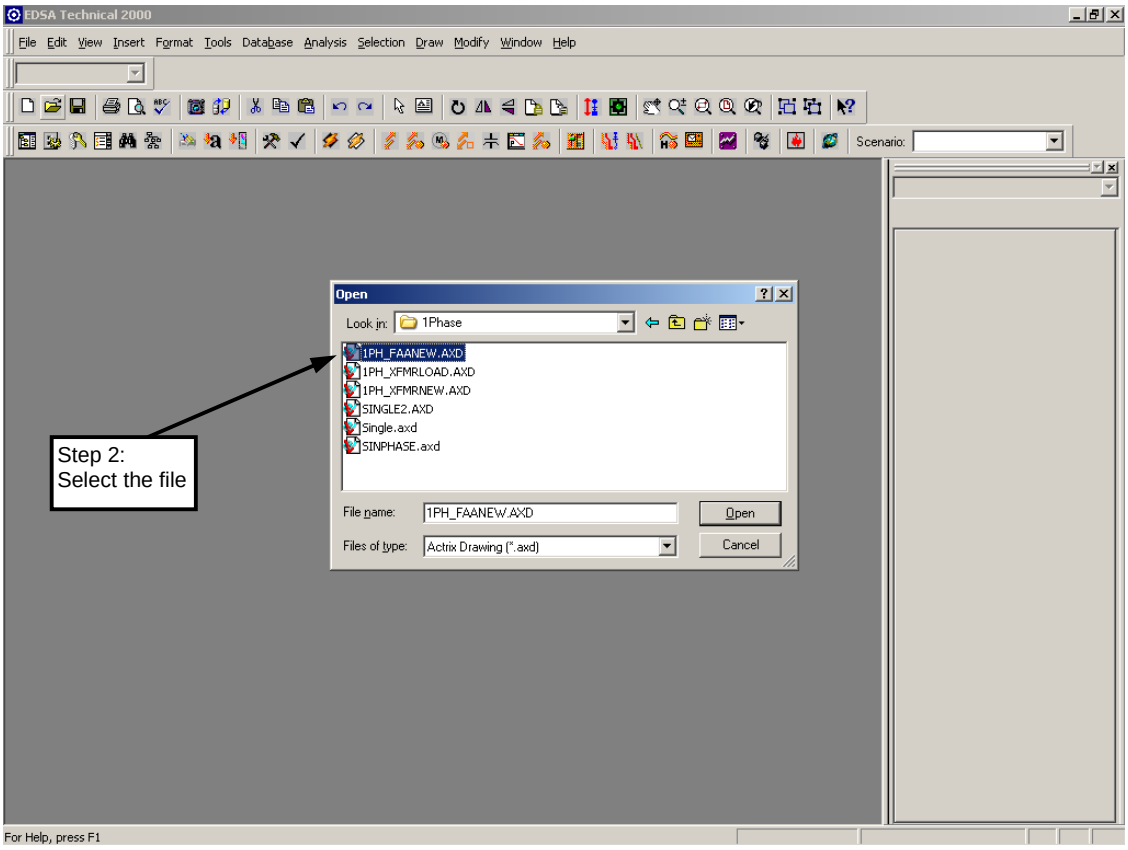
The following example will illustrate how to conduct a Single-Phase Load Flow study by using EDSA Advanced Single Phase Power Flow program.

4.1 Step 1: Invoke the EDSAT2K program.

Select “Open” icon; the following window will appear:



Select the file 1-PH_FAANEW.axd file and press Open button.



Once the file is uploaded into the EDSAT2K environment, the network appears on the EDSA design space as shown below. Using the left-mouse button select the Advanced Power Flow icon and then select Analysis: Single Phase.

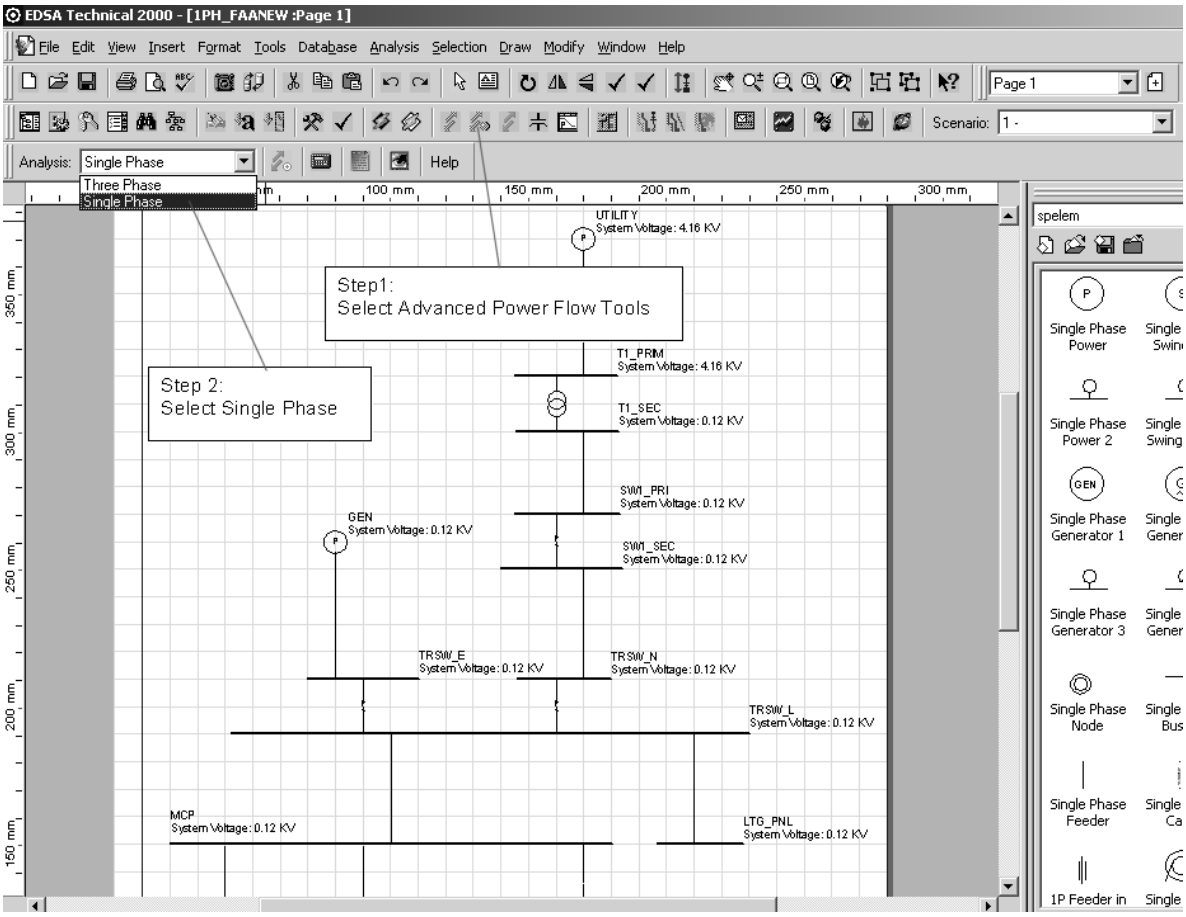
A. Single-phase network tapped from a single-phase utility source with 2-poles;

File name: **1PH_FAANEW.axd**

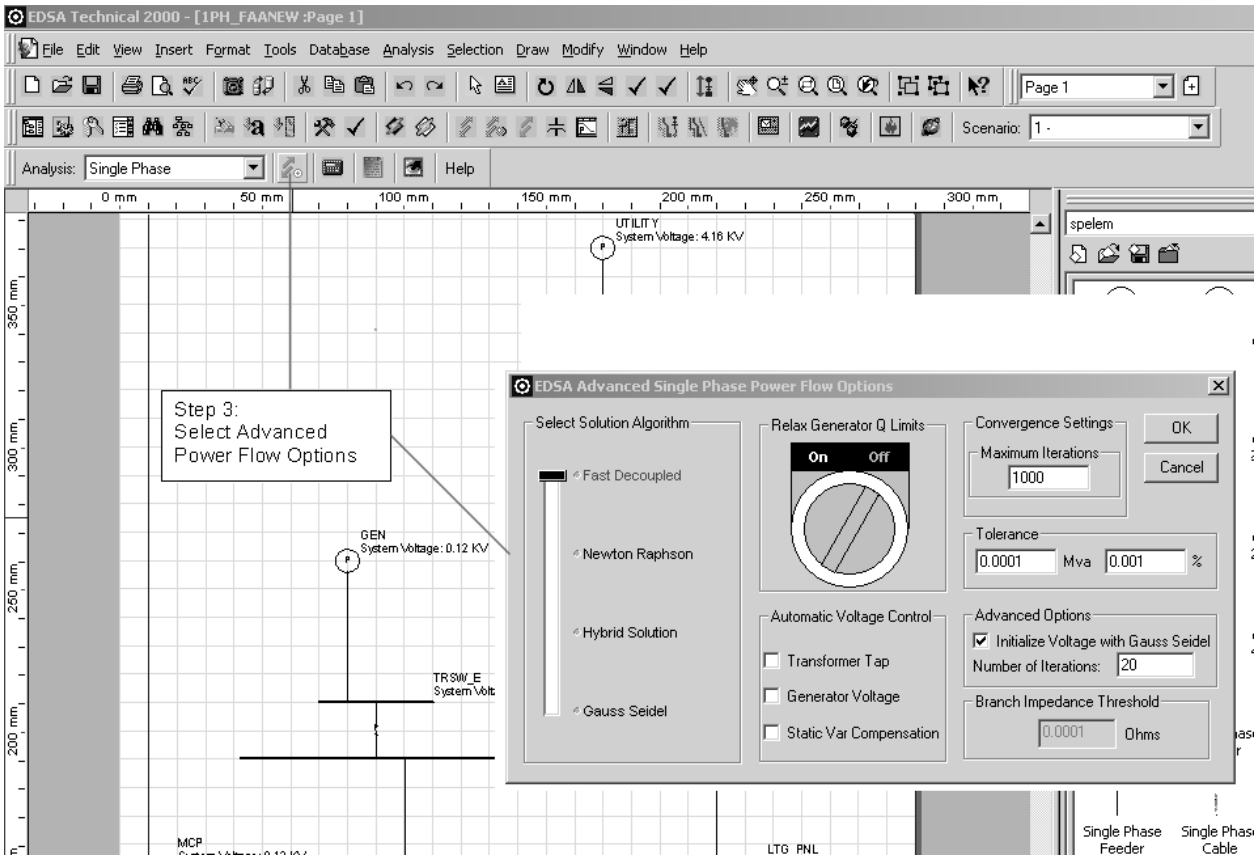
The single-phase network is connected to a single-phase Utility with 2 poles, between the hot and ground poles.

The study network has the following particulars:

- Power utility is 1-phase type;
- The single-phase network has 1 phase generators, motors and single-phase transformer;



4.4. Step 3: Select Advanced Power Flow Options:

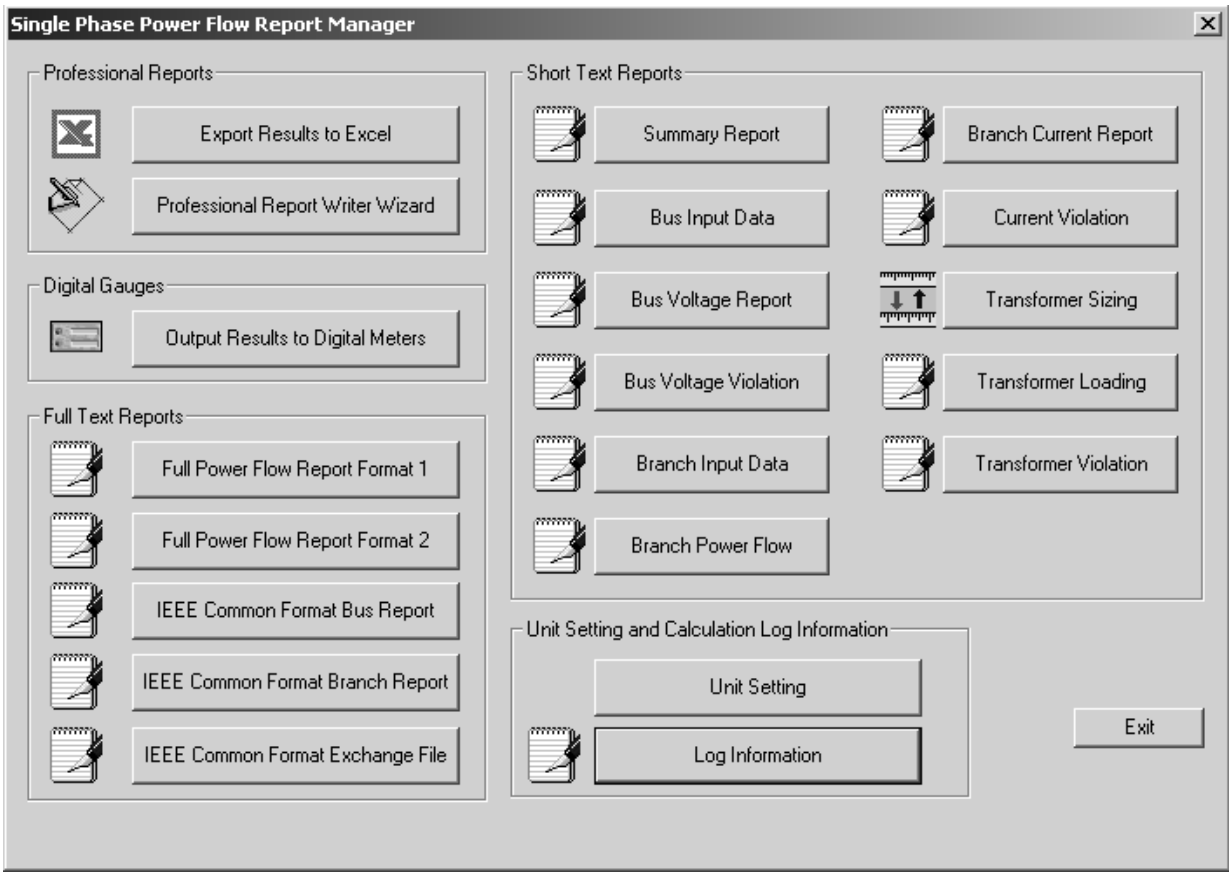


From within the EDSA Advanced Single Phase Power Flow Option, the user can select:

- The solution algorithm: Fast decupled, Newton Raphson, Hybrid Solution, Gauss Seidel;
- Relax or not the Generator Q limits: OFF or ON;
- Automatic voltage Control: Transformer Tap, Generator Voltage, Static VAR Compensation;
- Convergence settings: maximum number of iterations;
- Advanced Options: initialize voltage with Gauss Seidel method.

4.5. Step 5:

Select “Analyze” icon. After selecting “Analysis” icon and the program is run, if no errors, select “Single Phase Power Flow Report Manager” - the dialog window bellow will appear:



In the Single Phase Power Flow Report manager, the user has several options to select from.

4.6. Step 6: Select Full Power Flow Report, Format 1:

The Power Flow Results are listed:

```
                EDSA Advanced Single Phase Power Flow Program v4.10.00
                ======================================================

Project No. :                                  Page     : 1
Project Name:                                  Date     :
Title       :                                  Time     :
Drawing No. :                                  Company  :
Revision No.:                                  Engineer :
Jobfile Name: 1PH_FAANEW                       Check by :
Scenario    : 1 -                              Date     :

This is a sample for performing a single phase short-circuit study


                              System Information
                              ==================

    Base KVA                =      10000 (kva)
    Frequency               =         60 (HZ)
    Unit System             =         U.S. Standard
    MaxIterations           =       1000
    Error Tolerance         =      0.100 (kva),  0.000010 (pu),  0.0010 (%)

    # of Nodes entered      =         16
    # of Total Buses/Nodes  =         16
    # of Swing Buses        =          2
    # of Generators         =          0
    # of Loads              =          2
    # of Shunts             =          0

    # of Lines entered      =         15
    # Total Branches/lines  =         15
    # of Transformers       =          1
    # of Reactors           =          0
    # of C.B.               =          0
    # of Open Switches      =          0


                EDSA Advanced Single Phase Power Flow Program v4.10.00
                ======================================================

                  Summary of Total Generation and Demand of Phase A
                  =================================================

                              P(KW)         Q(KVAR)         S(KVA)        PF(%)

    Swing Bus(es):          12.454           7.715         14.650        85.01
    Generators   :           0.000           0.000          0.000         0.00
    Shunt        :           0.000           0.000          0.000         0.00

    Static Load  :           0.000           0.000          0.000         0.00
    Motor Load   :          12.396           7.682         14.584        85.00
    Total Loss   :           0.099           0.033
                          ----------      ----------
    Mismatch     :          -0.041           0.000
```

EDSA Advanced Single Phase Power Flow Program v4.10.00

Project No. :	Page : 3
Project Name:	Date :
Title :	Time :
Drawing No. :	Company :
Revision No.:	Engineer :
Jobfile Name: 1PH_FAANEW	Check by :
Scenario : 1 -	Date :

This is a sample for performing a single phase short-circuit study

Bus Data of Phase A

Bus	Label		V Mag(V)	V Ang(deg)	P (KW)	Q (KVAR)	C (KVAR)
GEN	EMERG GENERATOR	S	120	0	0	0	
UTILITY		S	4157	0	0	0	
BLDG_PNL	BUILDING PNL	N	120	0	0	0	
LTG_PNL	LIGHTING PANEL	N	120	0	0	0	
M1	MOTOR M1	L	115	0	-8	-5	
M2	MOTOR M2	L	120	0	-4	-3	
MCP	MCP	N	120	0	0	0	
PNL_A	PANEL A	N	120	0	0	0	
PNL_B	PANEL B	N	120	0	0	0	
SW1_PRI	SW1 PRIMARY	N	120	0	0	0	
SW1_SEC	SW1 SECONDARY	N	120	0	0	0	
T1_PRIM	T1 PRIMARY	N	4157	0	0	0	
T1_SEC	T1 SECONDARY	N	120	0	0	0	
TRSW_E	TRSF SW EMERG	N	120	0	0	0	
TRSW_L	TRSF SW LOAD	N	120	0	0	0	
TRSW_N	TRSF SW NORMAL	N	120	0	0	0	
Total Generating Sources					0	0	0
Total Bus Loads					-12	-8	

Branch Data of Phase A

From	To	C#	Code/Label	R (Ohms)	X (Ohms)	B/2 (Mhos)
GEN	TRSW_E	1	2-0	0.0021	0.0009	
MCP	BLDG_PNL	1	2	0.0333	0.0071	
MCP	PNL_A	1	2	0.0032	0.0007	
MCP	PNL_B	1	2	0.0024	0.0005	
PNL_A	M1	1	2	0.0024	0.0005	
PNL_B	M2	1	6	0.0065	0.0006	
SW1_PRI	SW1_SEC	1	200	0.0000	0.0002	
SW1_SEC	TRSW_N	1	2-0	0.0013	0.0005	
T1_SEC	SW1_PRI	1	2-0	0.0026	0.0010	
TRSW_E	TRSW_L	1	200	0.0000	0.0001	
TRSW_L	LTG_PNL	1	2-0	0.0375	0.0157	
TRSW_L	MCP	1	2-0	0.0013	0.0005	
TRSW_N	TRSW_L	1	200	0.0000	0.0001	
UTILITY	T1_PRIM	1		0.0103	0.0010	

Transformer & Line Voltage Regulator Data of Phase A

From	To	C#	Code/Label		R (%)	X (%)	F_Tap (PU)	T_Tap (PU)
T1_PRIM	T1_SEC	1	100KVA-1-PH	T	1.0900	2.6199	1.000	1.000

Bus Voltage Results of Phase A

BUS	Label		V (VOLTS)	DROP (%)	ANG (DEG)	P (KW)	Q (KVAR)	PF (%)
GEN	EMERG GENERATOR	S	120	-0.00	0.0	12	6	88.16
UTILITY		S	4157	0.00	0.0	1	1	43.12
BLDG_PNL	BUILDING PNL	N	120	0.35	0.0	0	0	
LTG_PNL	LIGHTING PANEL	N	120	0.22	0.0	0	0	
M1	MOTOR M1	L	119	0.72	0.1	-8	-5	85.00
M2	MOTOR M2	L	119	0.64	0.1	-4	-3	85.00
MCP	MCP	N	120	0.35	0.0	0	0	
PNL_A	PANEL A	N	119	0.56	0.1	0	0	
PNL_B	PANEL B	N	119	0.43	0.0	0	0	
SW1_PRI	SW1 PRIMARY	N	120	0.20	0.0	0	0	
SW1_SEC	SW1 SECONDARY	N	120	0.20	0.0	0	0	
T1_PRIM	T1 PRIMARY	N	4157	0.00	0.0	0	0	
T1_SEC	T1 SECONDARY	N	120	0.18	-0.0	0	0	
TRSW_E	TRSF SW EMERG	N	120	0.21	0.0	0	0	
TRSW_L	TRSF SW LOAD	N	120	0.22	0.0	0	0	
TRSW_N	TRSF SW NORMAL	N	120	0.22	0.0	0	0	

Branch Power Flow Values of Phase A

From	-> To	C#	Code/Label		P (KW)	Q (KVAR)	T-KVA (KVA)
GEN	TRSW_E	1	2-0		12	6	
MCP	BLDG_PNL	1	2		0	-0	
MCP	PNL_A	1	2		8	5	
MCP	PNL_B	1	2		4	3	
PNL_A	M1	1	2		8	5	
PNL_B	M2	1	6		4	3	
SW1_PRI	SW1_SEC	1	200		1	1	
SW1_SEC	TRSW_N	1	2-0		1	1	
T1_SEC	SW1_PRI	1	2-0		1	1	
TRSW_E	TRSW_L	1	200		12	6	
TRSW_L	LTG_PNL	1	2-0		0	-0	
TRSW_L	MCP	1	2-0		12	8	
TRSW_N	TRSW_L	1	200		1	1	
UTILITY	T1_PRIM	1			1	1	
T1_PRIM	T1_SEC	1	100KVA-1-PH	T	1	1	2

To	-> From	C#	Code/Label		P (KW)	Q (KVAR)	Loss (KW)	Loss (KVAR)
TRSW_E	GEN	1	2-0		-12	-6	0	0
BLDG_PNL	MCP	1	2		-0	-0	0	-0
PNL_A	MCP	1	2		-8	-5	0	0
PNL_B	MCP	1	2		-4	-3	0	0
M1	PNL_A	1	2		-8	-5	0	0

M2	PNL_B	1	6			-4	-3	0	0
SW1_SEC	SW1_PRI	1	200			-1	-1	0	0
TRSW_N	SW1_SEC	1	2-0			-1	-1	0	0
SW1_PRI	T1_SEC	1	2-0			-1	-1	0	0
TRSW_L	TRSW_E	1	200			-12	-6	0	0
LTG_PNL	TRSW_L	1	2-0			-0	-0	0	-0
MCP	TRSW_L	1	2-0			-12	-8	0	0
TRSW_L	TRSW_N	1	200			-1	-1	0	0
T1_PRIM	UTILITY	1				-1	-1	0	0
T1_SEC	T1_PRIM	1	100KVA-1-PH		T	-1	-1	0	0

Branch Current Flow Values of Phase A

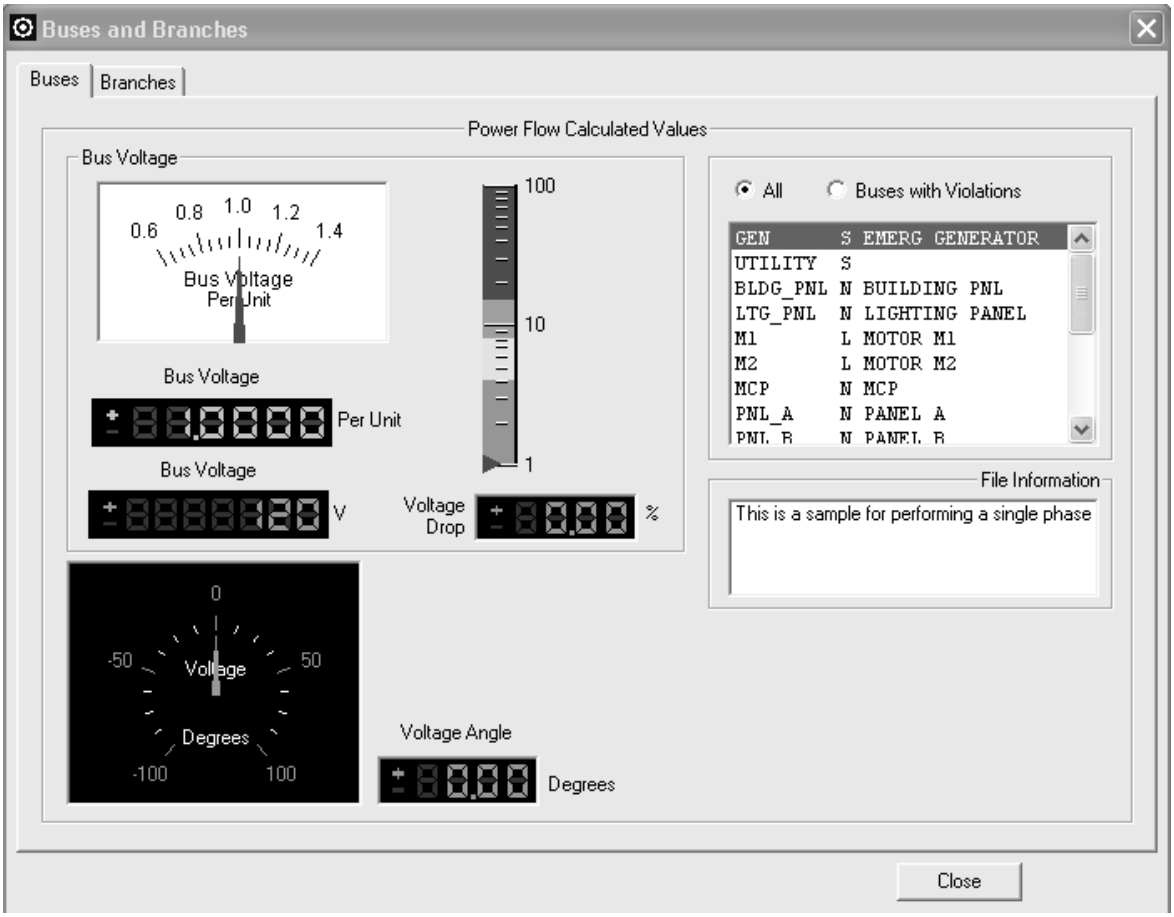
From	To	C#	Code/Label		CURRENT (A)	ANGLE (Deg)	AMPACITY (A)	F-LOADING (%)
GEN	TRSW_E	1	2-0		111	-28	184	61%
MCP	BLDG_PNL	1	2		0	3	115	0%
MCP	PNL_A	1	2		80	-32	121	67%
MCP	PNL_B	1	2		42	-32	121	35%
PNL_A	M1	1	2		80	-32	121	67%
PNL_B	M2	1	6		42	-32	68	61%
SW1_PRI	SW1_SEC	1	200		13	-63	200	7%
SW1_SEC	TRSW_N	1	2-0		13	-63	184	7%
T1_SEC	SW1_PRI	1	2-0		13	-63	175	8%
TRSW_E	TRSW_L	1	200		111	-28	200	56%
TRSW_L	LTG_PNL	1	2-0		0	9	175	0%
TRSW_L	MCP	1	2-0		122	-32	184	67%
TRSW_N	TRSW_L	1	200		13	-63	200	7%
UTILITY	T1_PRIM	1			0	-64	150	0%
T1_PRIM	T1_SEC	1	100KVA-1-PH	T	0	-63		

Transformer & Line Voltage Regulator Loading of Phase A

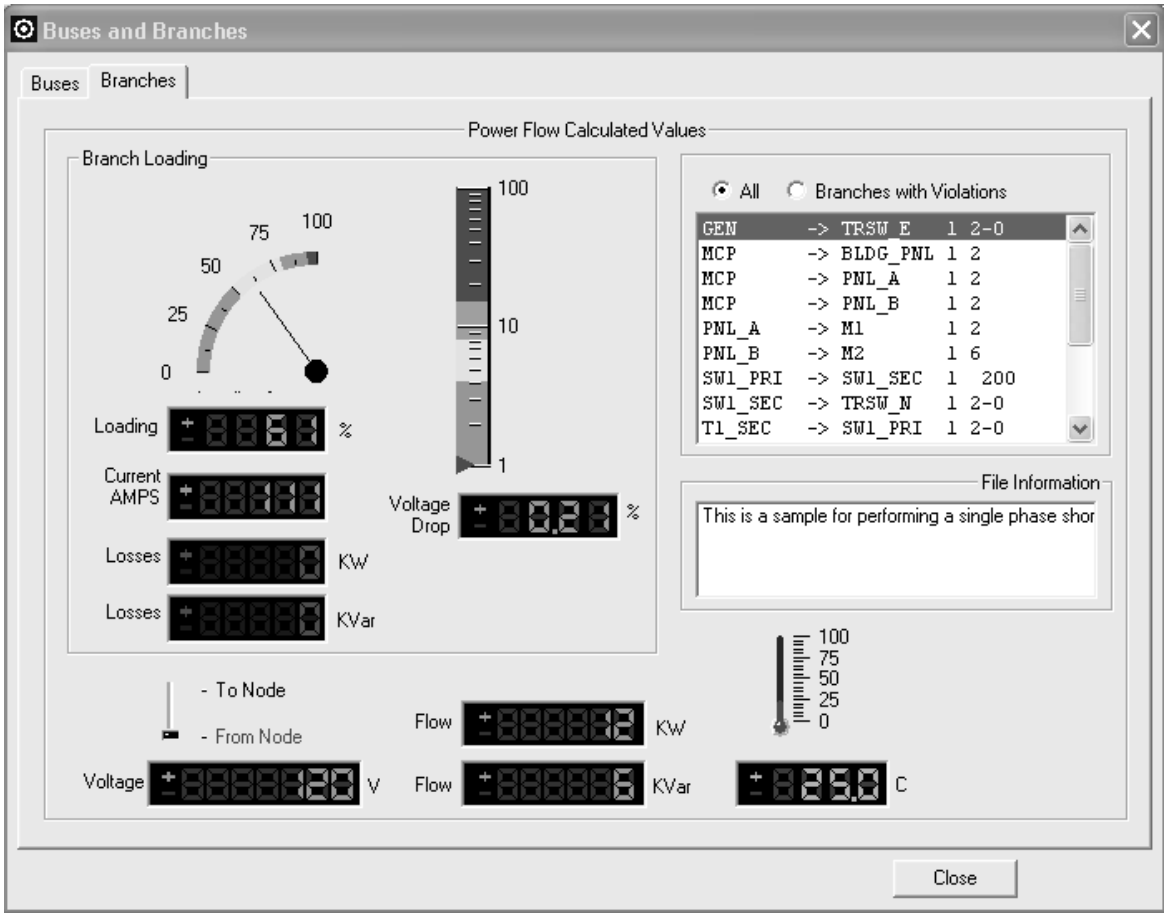
From	To	C#	Code/Label		Capacity (KVA)	Loading (KVA)	Loading (%)	Tap (PU)
T1_PRIM	T1_SEC	1	100KVA-1-PH	T	25	2	6%	1.000

4.7 Step 7: In the single Phase Power Flow Manager, select:
Output Results to digital meters. The following window will appear:

For Buses:

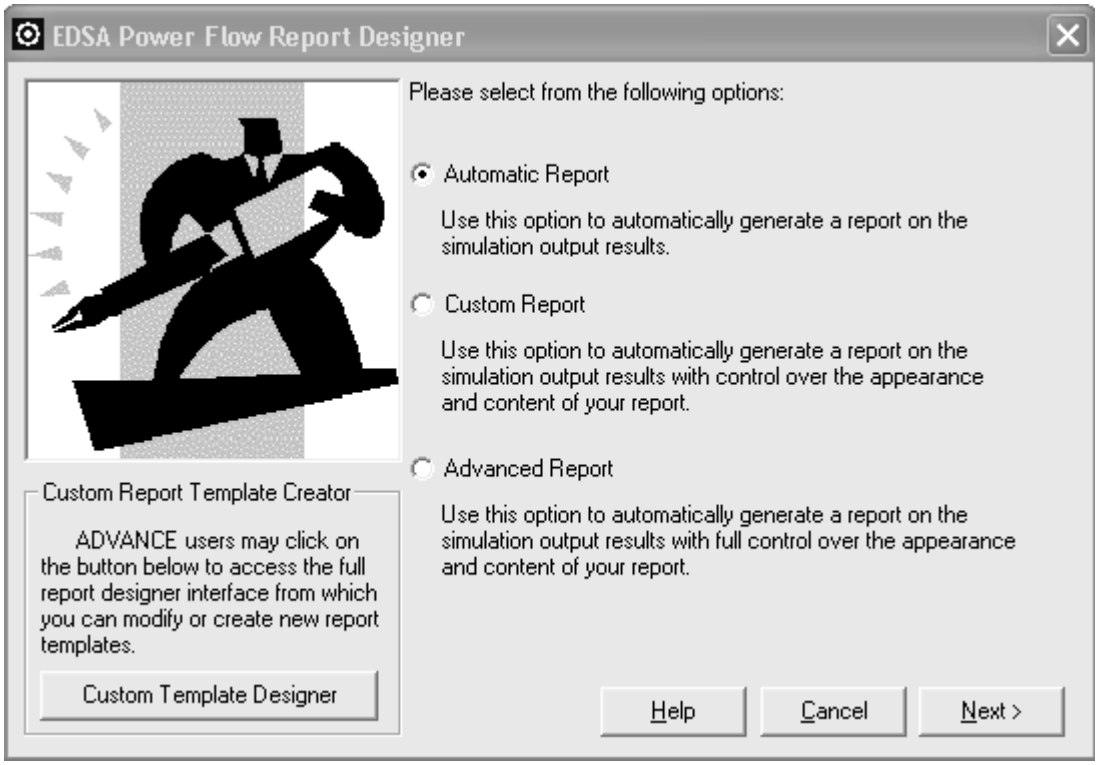


For Branches:



4.8 Step 8: In the single Phase Power Flow Manager, select:

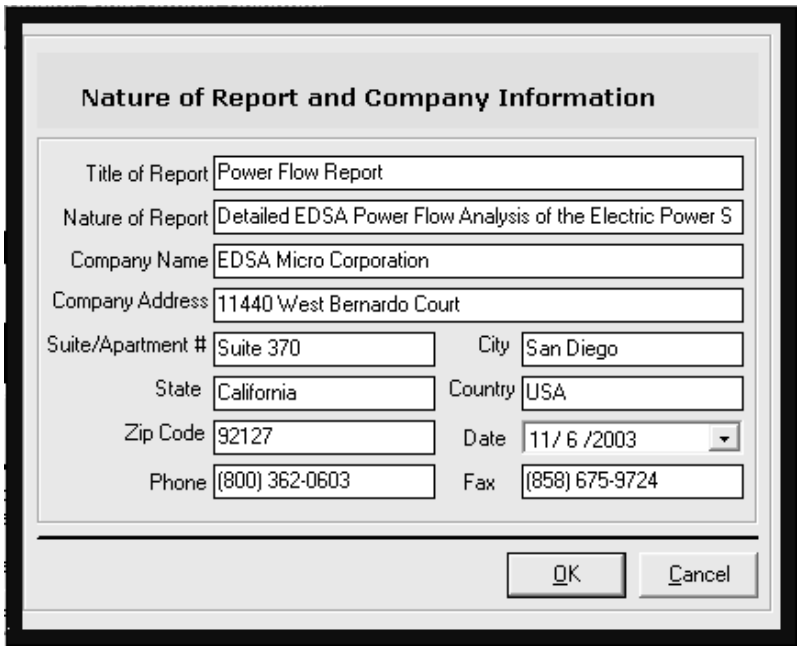
Professional Report Writer Wizard and follow the steps provided:



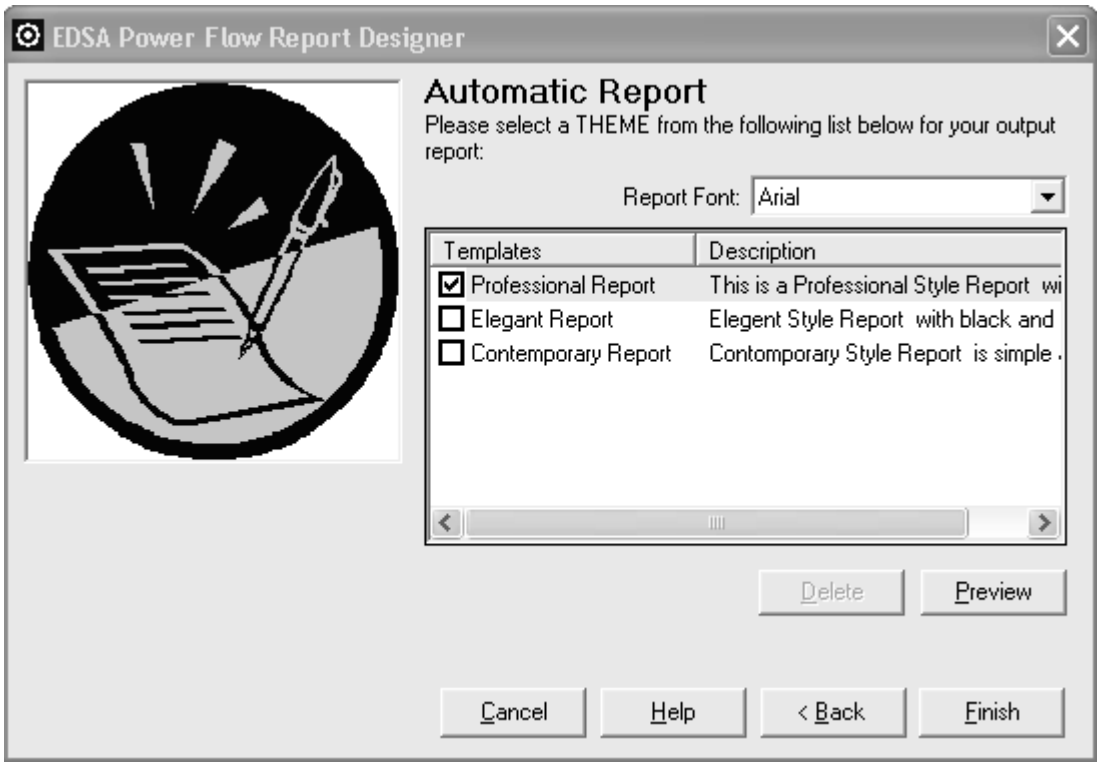
In the EDSA Power Flow Report Designer, the user can select one of the following options:

- Automatic Report;
- Custom Report;
- Advanced Report.

Select Automatic Report, and click onto Next button: the following window is displayed:



In the above window, the user can input his particulars. Click OK button. The Automatic Report window is displayed. Select the appropriate template, and then click onto the FINISH button.



B. Single-phase network tapped from a three-phase utility source with 2-poles;

File name: **1PH_XFMRLOAD.axd**

In this part of the tutorial a Single-Phase Network is connected to a Three-Phase Utility with 2 poles, having a Line-to-Line connection to the Utility.

The study network has the following particulars:

- Power utility is 3-phase type;
- To provide the dual voltage 0.24 KV and 0.12 KV a 1-single phase mid tap transformer is connected to the Utility. The transformer secondary is center-tapped and center leg grounded (some times known as Scott connection). Loads rated 0.12 KV are connected from the “hot” wire to the ground. Heavier loads requiring 0.24 KV are connected between the two “hot” phase (or phase-to-phase connection);
- The single-phase network has single-phase loads and motors and panels supplied at 240 V and 120 V;
- The outside phase (L-L) need to have 2-pole devices represent in order to clear the fault;
- 120 V legs, connected between the outer phases most often are single-phase.

Open the file 1PH_XFMRLOAD.axd and follow the same steps described so far.

The following is the Output Text Report.

```
EDSA Advanced Single Phase Power Flow Program v4.10.00
======================================================

Project No. :                              Page     : 1
Project Name:                              Date     :
Title       :                              Time     :
Drawing No. :                              Company  :
Revision No.:                              Engineer :
Jobfile Name: 1PH_XFMRLOAD                 Check by :
Scenario    : 1 -                          Date     :


                          System Information
                          ==================

    Base KVA                =      10000 (kva)
    Frequency               =         60 (HZ)
    Unit System             =         U.S. Standard
    MaxIterations           =       1000
    Error Tolerance         =      1.000 (kva),  0.000100 (pu),  0.0100 (%)

    # of Nodes entered       =         24
    # of Total Buses/Nodes   =         24
    # of Swing Buses         =          1
    # of Generators          =          0
    # of Loads               =          2
    # of Shunts              =          0

    # of Lines entered       =         22
    # Total Branches/lines   =         23
    # of Transformers        =          1
    # of Reactors            =          0
    # of C.B.                =          0
    # of Open Switches       =          0
```

Summary of Total Generation and Demand of Phase A

	P(KW)	Q(KVAR)	S(KVA)	PF(%)
Swing Bus(es):	12.578	8.224	15.028	83.70
Generators :	0.000	0.000	0.000	0.00
Shunt :	0.000	0.000	0.000	0.00
Static Load :	8.500	5.268	10.000	85.00
Motor Load :	4.287	2.657	5.044	85.00
Total Loss :	0.461	0.267		
Mismatch :	-0.670	0.033		

Bus Data of Phase A

Bus	Label		V Mag(V)	V Ang(deg)	P (KW)	Q (KVAR)	C (KVAR)
UTILITY		S	7200	0	0.00	0.00	
BLDG		N	240	0	0.00	0.00	
LOAD1		L	230	0	-8.50	-5.27	
LTG_PNL		N	240	0	0.00	0.00	
MCP		N	240	0	0.00	0.00	
MOTOR1		L	115	0	-4.29	-2.66	
PNL_A		N	240	0	0.00	0.00	
PNL_B		N	240	0	0.00	0.00	
SW_LINE		N	240	0	0.00	0.00	
SW_LOAD		N	240	0	0.00	0.00	
T1_PRIM		N	7200	0	0.00	0.00	
T1_SEC		N	240	0	0.00	0.00	
TRSW_L		N	240	0	0.00	0.00	
TRSW_N		N	240	0	0.00	0.00	
XBUDG		N	120	0	0.00	0.00	
XLTG_PNL		N	120	0	0.00	0.00	
XMCP		N	120	0	0.00	0.00	
XPNL_A		N	120	0	0.00	0.00	
XPNL_B		N	120	0	0.00	0.00	
XSW_LINE		N	120	0	0.00	0.00	
XSW_LOAD		N	120	0	0.00	0.00	
XT1_SEC		N	120	0	0.00	0.00	
XTRAW_N		N	120	0	0.00	0.00	
XTRSW_L		N	120	0	0.00	0.00	
Total Generating Sources					0.00	0.00	0.00
Total Bus Loads					-12.79	-7.92	

Branch Data of Phase A

From	To	C#	Code/Label	R (Ohms)	X (Ohms)	B/2 (Mhos)
BLDG	LOAD1	1	1-0	0.0221	0.0071	
MCP	BLDG	1	1-0	0.0265	0.0070	
MCP	PNL_A	1	1-0	0.0264	0.0053	
MCP	PNL_B	1	1-0	0.0211	0.0043	
SW_LINE	SW_LOAD	1	1000	0.0000	0.0001	
SW_LOAD	TRSW_N	1	1-0	0.0220	0.0087	
T1_SEC	SW_LINE	1	1-0	0.0044	0.0017	
TRSW_L	LTG_PNL	1	1-0	0.0396	0.0157	

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From	To	C#	Code/Label	R (Ohms)	X (Ohms)	B/2 (Mhos)
TRSW_L	MCP	1	1-0	0.0484	0.0191	
TRSW_N	TRSW_L	1	1000	0.0000	0.0001	
UTILITY	T1_PRIM	1	1-0	0.1075	0.0086	
XMCP	XBUDG	1	1-0	0.0265	0.0070	
XMCP	XPNL_A	1	1-0	0.0264	0.0053	
XMCP	XPNL_B	1	1-0	0.0211	0.0043	
XPNL_A	MOTOR1	1	1-0	0.0221	0.0071	
XSW_LINE	XSW_LOAD	1	1000	0.0000	0.0001	
XSW_LOAD	XTRAW_N	1	1-0	0.0220	0.0087	
XT1_SEC	XSW_LINE	1	1-0	0.0044	0.0017	
XTRAW_N	XTRSW_L	1	1000	0.0000	0.0001	
XTRSW_L	XLTG_PNL	1	1-0	0.0396	0.0157	
XTRSW_L	XMCP	1	1-0	0.0484	0.0191	

Transformer & Line Voltage Regulator Data of Phase A

From	To	C#	Code/Label		R (%)	X (%)	F_Tap (PU)	T_Tap (PU)
T1_PRIM	T1_SEC	1	25-1	P	0.1000	1.9000	1.000	1.000
T1_PRIM	XT1_SEC	1	25-1	P	0.1500	2.2800	1.000	1.000

Bus Voltage Results of Phase A

BUS	Label		V (VOLTS)	DROP (%)	ANG (DEG)	P (KW)	Q (KVAR)	PF (%)
UTILITY		S	7200	-0.00	0.0	12.58	8.22	83.70
BLDG		N	234	2.34	-0.1	0.00	0.00	
LOAD1		L	233	2.75	-0.1	-8.50	-5.27	85.00
LTG_PNL		N	238	0.95	-0.3	0.00	0.00	
MCP		N	236	1.87	-0.2	0.00	0.00	
MOTOR1		L	114	4.77	0.4	-4.29	-2.66	85.00
PNL_A		N	236	1.87	-0.2	0.00	0.00	
PNL_B		N	236	1.87	-0.2	0.00	0.00	
SW_LINE		N	239	0.53	-0.4	0.00	0.00	
SW_LOAD		N	239	0.53	-0.4	0.00	0.00	
T1_PRIM		N	7200	0.00	0.0	0.00	0.00	
T1_SEC		N	239	0.45	-0.4	0.00	0.00	
TRSW_L		N	238	0.95	-0.3	0.00	0.00	
TRSW_N		N	238	0.95	-0.3	0.00	0.00	
XBUDG		N	116	3.15	0.1	0.00	0.00	
XLTG_PNL		N	118	1.30	-0.1	0.00	0.00	
XMCP		N	116	3.15	0.1	0.00	0.00	
XPNL_A		N	115	3.98	0.3	0.00	0.00	

XPNL_B	N	116	3.15	0.1	0.00	0.00
XSW_LINE	N	119	0.45	-0.2	0.00	0.00
XSW_LOAD	N	119	0.45	-0.2	0.00	0.00
XT1_SEC	N	120	0.28	-0.2	0.00	0.00
XTRAW_N	N	118	1.30	-0.1	0.00	0.00
XTRSW_L	N	118	1.30	-0.1	0.00	0.00
XLTG_PNL	N	116	3.17	-0.2	0.00	0.00
XMCP	N	114	5.08	0.0	0.00	0.00
XPNL_A	N	113	5.99	0.3	0.00	0.00
XPNL_B	N	114	5.08	0.0	0.00	0.00
XSW_LINE	N	117	2.30	-0.3	0.00	0.00
XSW_LOAD	N	117	2.30	-0.3	0.00	0.00
XT1_SEC	N	117	2.12	-0.3	0.00	0.00
XTRAW_N	N	116	3.17	-0.2	0.00	0.00
XTRSW_L	N	116	3.17	-0.2	0.00	0.00

* : Voltage Controlled Buses

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Branch Power Flow Values of Phase A

From -> To		C#	Code/Label		P (KW)	Q (KVAR)	T-KVA (KVA)
BLDG	LOAD1	1	1-0		8.66	5.32	
MCP	BLDG	1	1-0		8.61	5.33	
MCP	PNL_A	1	1-0		0.00	0.00	
MCP	PNL_B	1	1-0		0.00	0.00	
SW_LINE	SW_LOAD	1	1000		8.75	5.36	
SW_LOAD	TRSW_N	1	1-0		8.77	5.36	
T1_SEC	SW_LINE	1	1-0		8.78	5.36	
TRSW_L	LTG_PNL	1	1-0		0.00	0.00	
TRSW_L	MCP	1	1-0		8.74	5.35	
TRSW_N	TRSW_L	1	1000		8.72	5.35	
UTILITY	T1_PRIM	1	1-0		12.58	8.22	
XMCP	XBUDG	1	1-0		0.00	0.00	
XMCP	XPNL_A	1	1-0		3.87	2.72	
XMCP	XPNL_B	1	1-0		0.00	0.00	
XPNL_A	MOTOR1	1	1-0		4.07	2.72	
XSW_LINE	XSW_LOAD	1	1000		4.57	2.75	
XSW_LOAD	XTRAW_N	1	1-0		4.40	2.75	
XT1_SEC	XSW_LINE	1	1-0		4.41	2.75	
XTRAW_N	XTRSW_L	1	1000		4.54	2.74	
XTRSW_L	XLTG_PNL	1	1-0		0.00	0.00	
XTRSW_L	XMCP	1	1-0		4.35	2.74	
T1_PRIM	T1_SEC	1	25-1	P	8.76	5.44	10.32
T1_PRIM	XT1_SEC	1	25-1	P	4.57	2.78	5.35

To ->	From	C#	Code/Label	P (KW)	Q (KVAR)	Loss (KW)	Loss (KVAR)
LOAD1	BLDG	1	1-0	-8.62	-5.30	0.04	0.01
BLDG	MCP	1	1-0	-8.57	-5.31	0.05	0.01
PNL_A	MCP	1	1-0	0.00	0.00	0.00	0.00
PNL_B	MCP	1	1-0	0.00	0.00	0.00	0.00
SW_LOAD	SW_LINE	1	1000	-8.75	-5.36	0.00	0.00
TRSW_N	SW_LOAD	1	1-0	-8.73	-5.35	0.04	0.02
SW_LINE	T1_SEC	1	1-0	-8.77	-5.36	0.01	0.00
LTG_PNL	TRSW_L	1	1-0	0.00	0.00	0.00	0.00
MCP	TRSW_L	1	1-0	-8.65	-5.32	0.09	0.04
TRSW_L	TRSW_N	1	1000	-8.72	-5.35	0.00	0.00
T1_PRIM	UTILITY	1	1-0	-12.58	-8.22	0.00	0.00
XBUDG	XMCP	1	1-0	0.00	0.00	0.00	0.00
XPNL_A	XMCP	1	1-0	-3.83	-2.72	0.04	0.01
XPNL_B	XMCP	1	1-0	0.00	0.00	0.00	0.00

MOTOR1	XPNL_A	1 1-0		-4.03	-2.71	0.04	0.01
XSW_LOAD	XSW_LINE	1 1000		-4.57	-2.75	0.00	0.00
XTRAW_N	XSW_LOAD	1 1-0		-4.36	-2.74	0.04	0.02
XSW_LINE	XT1_SEC	1 1-0		-4.41	-2.75	0.01	0.00
XTRSW_L	XTRAW_N	1 1000		-4.54	-2.73	0.00	0.00
XLTG_PNL	XTRSW_L	1 1-0		0.00	0.00	0.00	0.00
XMCP	XTRSW_L	1 1-0		-4.26	-2.70	0.09	0.04
T1_SEC	T1_PRIM	1 25-1	P	-8.76	-5.36	0.00	0.08
XT1_SEC	T1_PRIM	1 25-1	P	-4.57	-2.75	0.00	0.03

Branch Current Flow Values of Phase A

From	To	C# Code/Label		CURRENT (A)	ANGLE (Deg)	AMPACITY (A)	F-LOADING (%)
BLDG	LOAD1	1 1-0		43	-32	157	28%
MCP	BLDG	1 1-0		43	-32	157	27%
MCP	PNL_A	1 1-0		0	-0	157	0%
MCP	PNL_B	1 1-0		0	-0	157	0%
SW_LINE	SW_LOAD	1 1000		43	-32	0	
SW_LOAD	TRSW_N	1 1-0		43	-32	157	27%
T1_SEC	SW_LINE	1 1-0		43	-32	157	27%
TRSW_L	LTG_PNL	1 1-0		0	-0	157	0%
TRSW_L	MCP	1 1-0		43	-32	157	27%
TRSW_N	TRSW_L	1 1000		43	-32	0	
UTILITY	T1_PRIM	1 1-0		2	-33	157	1%
XMCP	XBUDG	1 1-0		0	0	157	0%
XMCP	XPNL_A	1 1-0		41	-35	157	26%
XMCP	XPNL_B	1 1-0		0	0	157	0%
XPNL_A	MOTOR1	1 1-0		42	-33	157	27%
XSW_LINE	XSW_LOAD	1 1000		45	-31	0	
XSW_LOAD	XTRAW_N	1 1-0		43	-32	157	28%
XT1_SEC	XSW_LINE	1 1-0		43	-32	157	28%
XTRAW_N	XTRSW_L	1 1000		45	-31	0	
XTRSW_L	XLTG_PNL	1 1-0		0	-0	157	0%
XTRSW_L	XMCP	1 1-0		43	-32	157	28%
T1_PRIM	T1_SEC	1 25-1	P	1	-32		
T1_PRIM	XT1_SEC	1 25-1	P	1	-31		

Transformer & Line Voltage Regulator Loading of Phase A

From	To	C# Code/Label		Capacity (KVA)	(KVA)	Loading (%)	Tap (PU)
T1_PRIM	T1_SEC	1 25-1	P	25.00	10.32	41%	1.000
T1_PRIM	XT1_SEC	1 25-1	P	25.00	5.35	21%	1.000

Comments:

In this example, EDSA user can see the bus line-to-line voltages and line-to-ground voltages as the Utility is a three-phase type, and the single-phase network is connected to the utility “Line-to-Line. The mid tap transformer is connected to the Utility. The transformer secondary is center-tapped and center leg grounded (some times known as Scott connection). Loads rated 120 V are connected from the “hot” wire to the ground. Heavier loads requiring 240 V are connected between the two “hot” phases (or phase-to-phase connection);