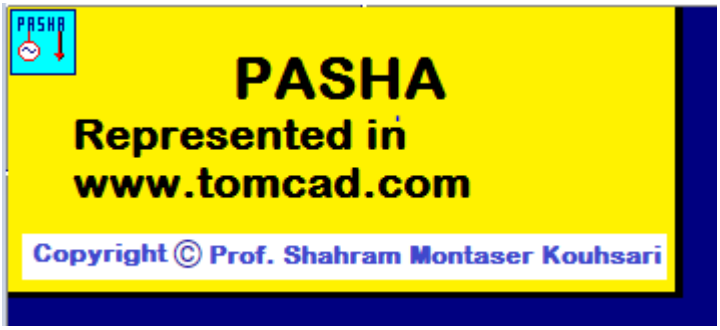


Chapter 3
The drawing section

PASHA provides a fully graphical User Interface (GUI) for drawing your single-line diagram. Here you can graphically add, delete, move, connect elements, locate a set of elements in an area called window, zoom in a window or in a selectable area, enter directly to the edit pages described in chapter four to edit properties of the elements and set their operating status, etc.

PASHA's single-line diagram is a one-line representation of a balanced three-phase system. The single-line diagram is the starting point for all studies. You can graphically construct your electrical system by connecting the buses, lines, transformers, motors, and generators, in any order. You can use special keys or double-click on elements to open their editors and edit the engineering properties, which include ratings, settings, loading, connection, etc. When you enter the data of circuit breakers and protective devices located in a line, PASHA automatically places them in the single-line diagram. The symbols of shunt elements and some others will be automatically modified depending to their data to minimize the drawing entry.

When you want to create a new single-line diagram presentation, you must enter to the drawing section. The drawing section is entered from the main menu by selecting either of the following main options:

i. [DRAW A NEW NETWORK DIAGRAM] - this option starts the drawing section. Any previous networks and data are cleared from memory and the user is presented with a clear screen - a blank sheet on which to start drawing.

ii. [MODIFY THE PRESENT NETWORK DIAGRAM] - this option starts the drawing section with an already existing network, which has been drawn at an earlier time. This option therefore enables a user to re-enter the drawing section at any time without clearing either the existing system diagram or its data.

The drawing procedure is identical for both of the above options. It is therefore possible to describe the functioning of both options at the same time.

3.1 Network drawing mode

As a rule the elements can be added only in drawing mode, i.e., they CANNOT be added in any study mode. Drawing mode can best be described by thinking of the screen as a piece of paper and the mouse graphics cursor as an intelligent paintbrush. The paintbrush is always above the paper, and only makes contact with it when a suitable key is depressed, e.g. <S>, <J>, <G> are valid drawing keys. When this occurs, the program draws the appropriate symbol at the point over which the cursor is positioned.

The drawing procedure in this way is therefore made up of two distinct steps:

(i) Position the cursor at the required point for the symbol
(ii) Depress a key to draw the required symbol

The other way is using tool bars instead of depressing a key. Click on an element symbol on the green box tool bars, then move the cursors to the required point and click to draw it. The tool bars can appear or disappear using small icons indicated by + , - .

A simple example makes this clear. Figure 3.1 shows the drawing screen when it has been entered from the [DRAW A NEW NETWORK DIAGRAM] option. The green tool bar contains all the symbols and the keys available in the drawing section. The position of the mouse cursor is shown by the mouse symbol.

Suppose the user wishes to draw a substation at point (a,b), as shown in figure 3.1. He then presses the <S> key that draws a substation symbol as shown in figure 3.2.

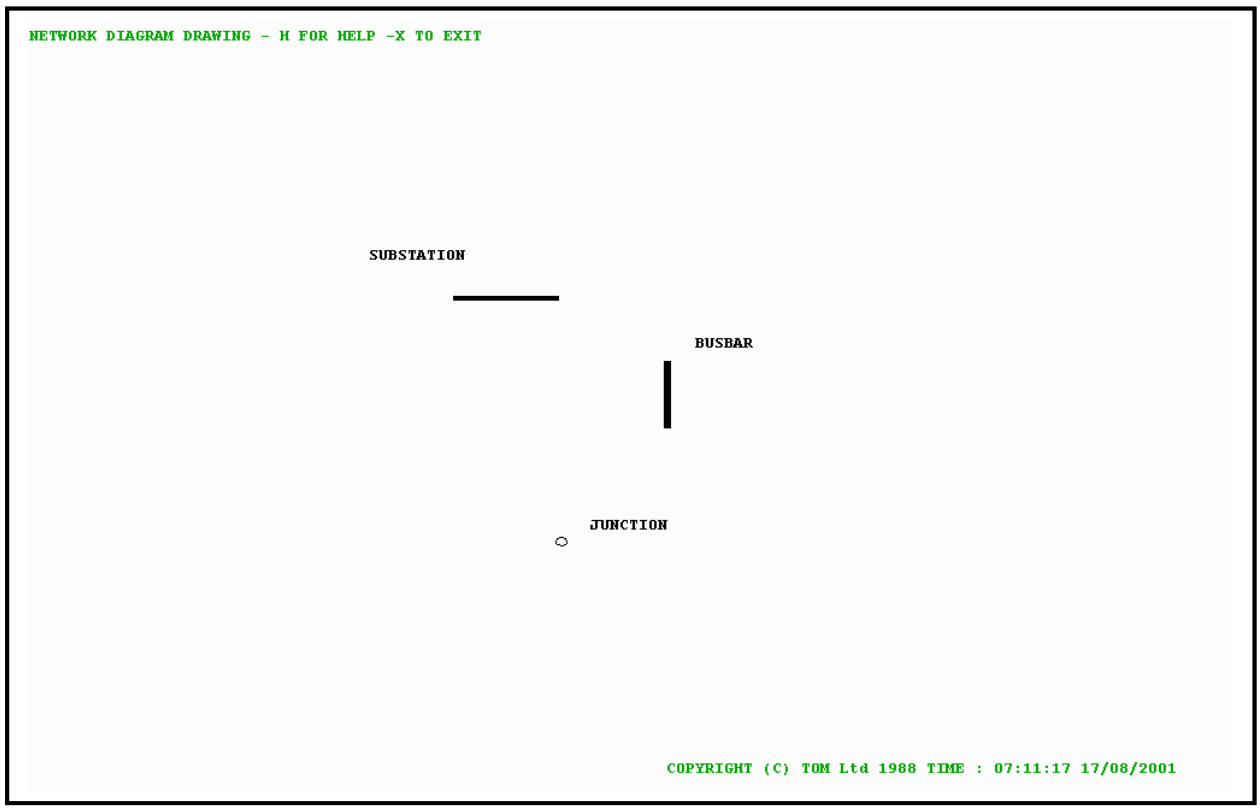
This basic technique is applicable for drawing the whole of the diagram. However, certain of the defined keys draw connections not implied by the current cursor position. This will be explained in detail as we look at the keys defined for drawing plant.

3.2 The drawing keys and tool bars

The available drawing symbols and the corresponding keys are shown in the green box tool bars (the keys are in red), refer to section 2.2.3. Most of the alphanumeric keys are defined to have some function in drawing mode. Those concerned with the basic drawing procedure are introduced in this section. The convention used in this section of the manual is to show each drawing element in isolation, rather than as a part of a network. This means that the figures showing each drawing element in turn, do not follow on from each other, i.e. it is not possible to recreate one figure using PASHA and then immediately draw the next figure without first deleting the previous elements from the screen. To illustrate this, consider figures 3.5 and 3.6. To get from figure 3.5 to figure 3.6 the following course of action should be taken:

Type <F> to 'forget' (section 3.5) the last entry (a generator)
Type <E> to 'erase and re-draw' diagram (section 3.4)
Type <I> to draw the induction motor symbol (section 3.2.2)

For a full example of the network drawing procedure the user should refer to section 3.3.


NETWORK DIAGRAM DRAWING - H FOR HELP -X TO EXIT
SUBSTATION
BUSBAR
JUNCTION
COPYRIGHT (C) TOM Ltd 1988 TIME : 07:11:17 17/08/2001

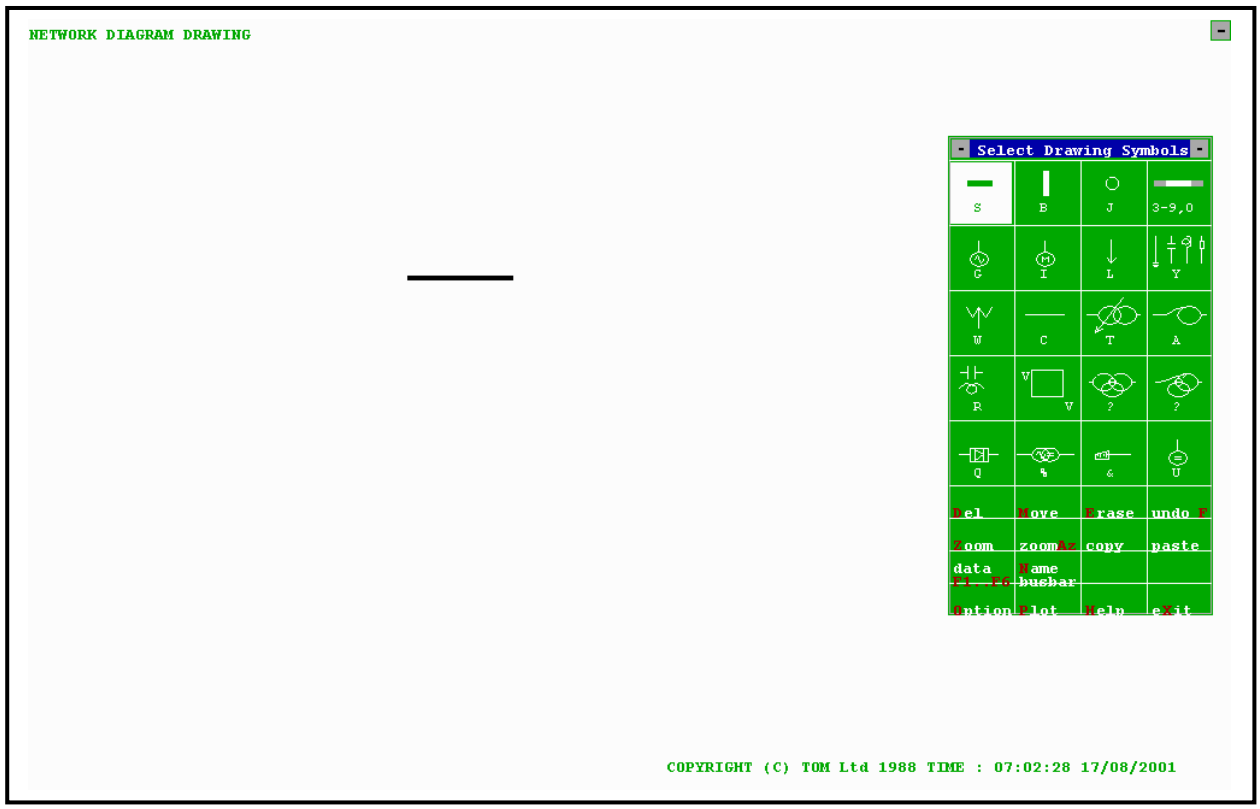

NETWORK DIAGRAM DRAWING
Select Drawing Symbols
S
B
J
3-9,0
G
I
L
Y
W
C
T
A
R
V
?
?
Q
U
Del
Move
Erase
undo F
Zoom
zoomAr
copy
paste
data
busbar
Option
Plot
Help
eXit
COPYRIGHT (C) TOM Ltd 1988 TIME : 07:02:28 17/08/2001

Figure 3-2

Figure 3-3

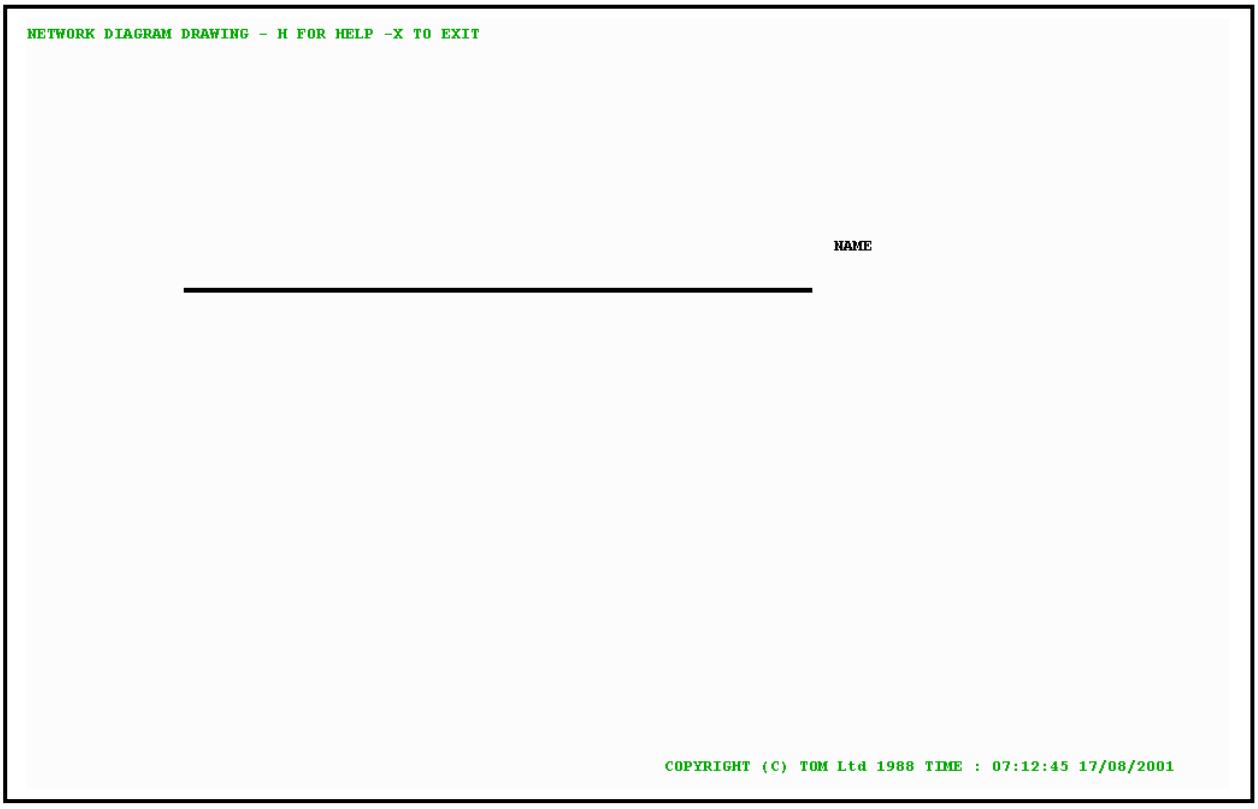


Figure 3-4

3.2.1 Substations, Busbar, and junctions

The three drawing keys defined in this section all draw elements directly beneath the cursor, normally without any connections (sometimes drawing a substation or junction will also terminate a connection - see 3.2.3.1). The <N> key is used to name junctions, busbars and substations. **The tool bars may also used to draw the following elements as highlighted in section 3.1. Note that the tool bars are diminished from the figures using <-> icon.**

The <S> key and the <B> key

The <S> key draws a substation (horizontal) symbol at the current cursor position. If a substation already exists at the current cursor position the substation is 'selected' as the 'current' substation, i.e. the one to which the next radial elements drawn are to be connected or from which a circuit is to be drawn. The default 'current' substation is the one drawn or selected most recently. Selection is also necessary before a substation can be named. (See the <N> key).

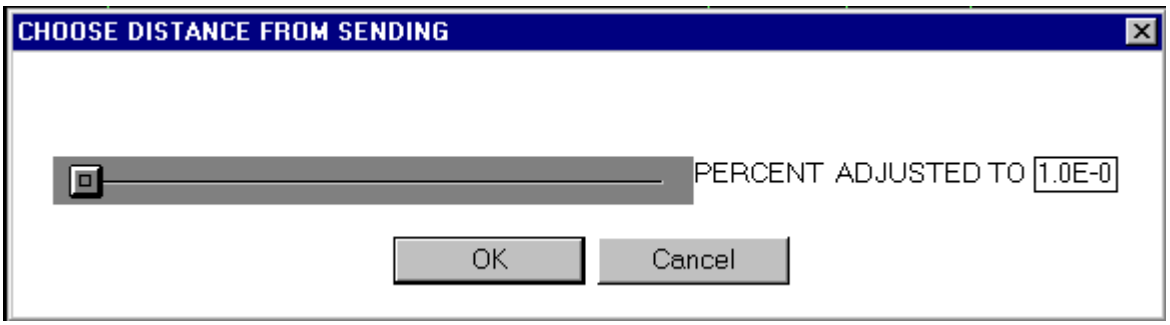
The <B> key also draws a substation (or can be named busbar) but it is vertical. Figure 3.3 shows a substation and a busbar drawn by pressing <S> and <B>.

The keys <3>, <4>, <5>, <6>, <7>, <8> and <9> also draw substation symbol but in bigger sizes respectively. It is possible to position the cursor over an existing substation or busbar and type any of these numbers to change the size of that substation. Figure 3.4 shows a substation symbol, which is drawn by pressing key <7> instead, of<S>. The Key <0> (ZERO) returns back the plant to normal size. **The function of these keys can also be selected from tool bars at the top right hand corner of the green box.**

The <J> key

Draws a junction symbol at the current cursor position. This functions in exactly the same way as the <S> key for drawing substations. In fact from the network's point of view, both junctions and substations represent nodes and are identical, except that the junction has a more compact symbol and should be used when space is at a premium, or if the node is not very prominent in the diagram. A junction symbol is shown in figure 3.3 too.

When a junction is drawn, its position is first checked against a preset distance from a connection line. If the junction lies on or within the distance, the computer asks if the user wants the junction to be positioned inside the line. If the answer is yes the computer asks for the distance from sending end and the connection is broken and the program will interpret this junction to be connected to that line with the distance specified by the user using the following menu.



The <N> key

The <N> key is used to name a substation or junction. It puts the terminal into alphanumeric mode to accept a name, starting at the cursor location, for the 'current' substation or junction. An 8-character name can then be input followed by the <CR> key. The name is stored and will be displayed in the selected position along with the diagram. Figure 3.3 shows the substation symbol, which is to be named. It came in this figure just for the sack of simplicity of manual. The cursor is positioned to point (c,d) and the <N> key is pressed. The alphanumeric cursor is displayed at (c,d) and the name is entered as 'NAME' which is terminated with the <CR> key, i.e. the following keys are

<N><A><M><E><CR>

This is shown in figure 3.4 too.

Note: when the results from the load flow and fault level sections are displayed on the diagram certain quantities are displayed below the name of the substation to which they refer, so the name should be positioned carefully.

It is very convenient to draw networks and then select NAME from toolbars and then click on a busbar (that is desired to be named) in order to select it and then click in an appropriate position to enter the name as described above.

3.2.2 Radial plants

This section describes the keys available to draw plant normally associated with a single substation or junction. They are termed 'radial' because they 'radiate' from a substation. The following keys draw radial plants i.e. those connected radialy to the substations or busbars. **If you select a radial element from the tool bars and click on a substation, busbar, or junction the element will not be drawn and just the substation will be selected as stated in section 3.2.1.**

The <G> key

Draws a generator symbol at the present cursor position and draws a connection to the current or the last drawn or selected substation (or junction). Figure 3.5 shows a generator symbol drawn connected to a substation. The cursor position when the <G> key was pressed is shown by the mouse cursor symbol. **You may use the tool bars as highlighted in section 3.1.**

The <I> key

Draws an induction motor symbol at the cursor position and draws a connection to the current substation. Figure 3.6 shows an induction motor symbol connected to a substation. **You may use the tool bars as highlighted in section 3.1.** Note: the <I> key is also used immediately after pressing the <W> key (draws an in-feeding transformer) to generate a source busbar which supplies the in-feeding transformer. See the <W> key below.

The <L> key

Draws loads symbol at the cursor position and connect it to the previous substation or selected substation. Figure 3.7 shows a load symbol connected to a substation. **You may use the tool bars as highlighted in section 3.1.**

The <Y> key

Draws a shunt symbol at the cursor position and draws a connection to the previous substation. Figure 3.8 shows seven shunt symbols connected to five substations. The symbols are modified automatically by PASHA after entering the data (See Chapter 4). **You may use the tool bars as highlighted in section 3.1.**

Note that the shunts connected to a Junction may act as an Arc furnace or TCR. The following drawing process may be used to convert a shunt to become these power system plants.

For Arc furnace, press <3> while the cursor is located on Junction (shunt must exist on this junction and the junction must have the name). The computer then asks for the required shunt and the transformer and the connection lines. Just click on the appropriate elements in response to the computer questions. For more information about this section please refer to on line help on PASHA.

For TCR, press <4> while the cursor is located on Junction (shunt must exist on this junction and the junction must have a name). The computer then asks for the shunt and the lines, which control actions, must be performed. Just click on the appropriate line that the power factor of its sending end is going to be adjusted by computer. For more information about this section please refer to on line help on PASHA. If there are two TCRs and their control actions are dependent to each other, just press <5> instead of <4> for the second TCR.

The <U> key

Draws a DC machine symbol at the present cursor position and draws a connection to the current or the last drawn or selected substation (or junction). **You may use the tool bars as highlighted in section 3.1.**

The <&> key

Draws a battery symbol at the present cursor position and draws a connection to the current or the last drawn or selected substation (or junction). **You may use the tool bars as highlighted in section 3.1.**

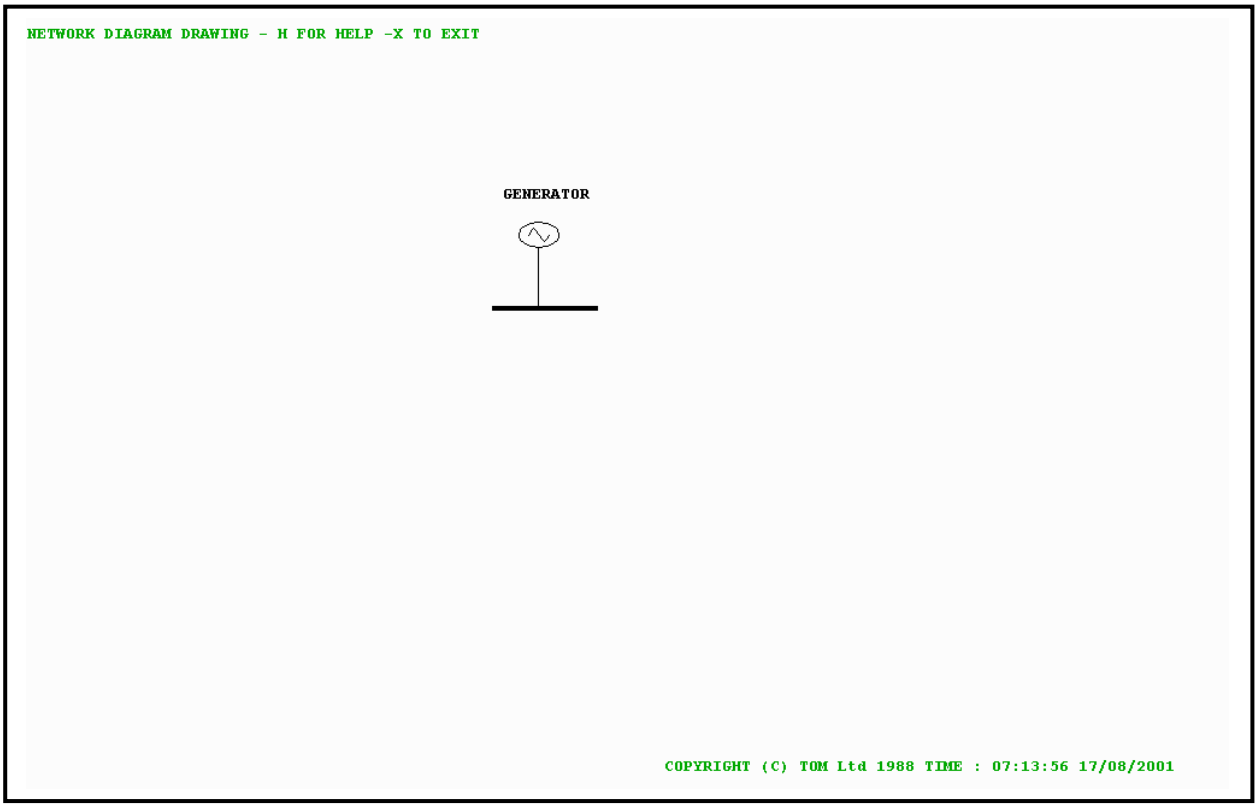


Figure 3-5

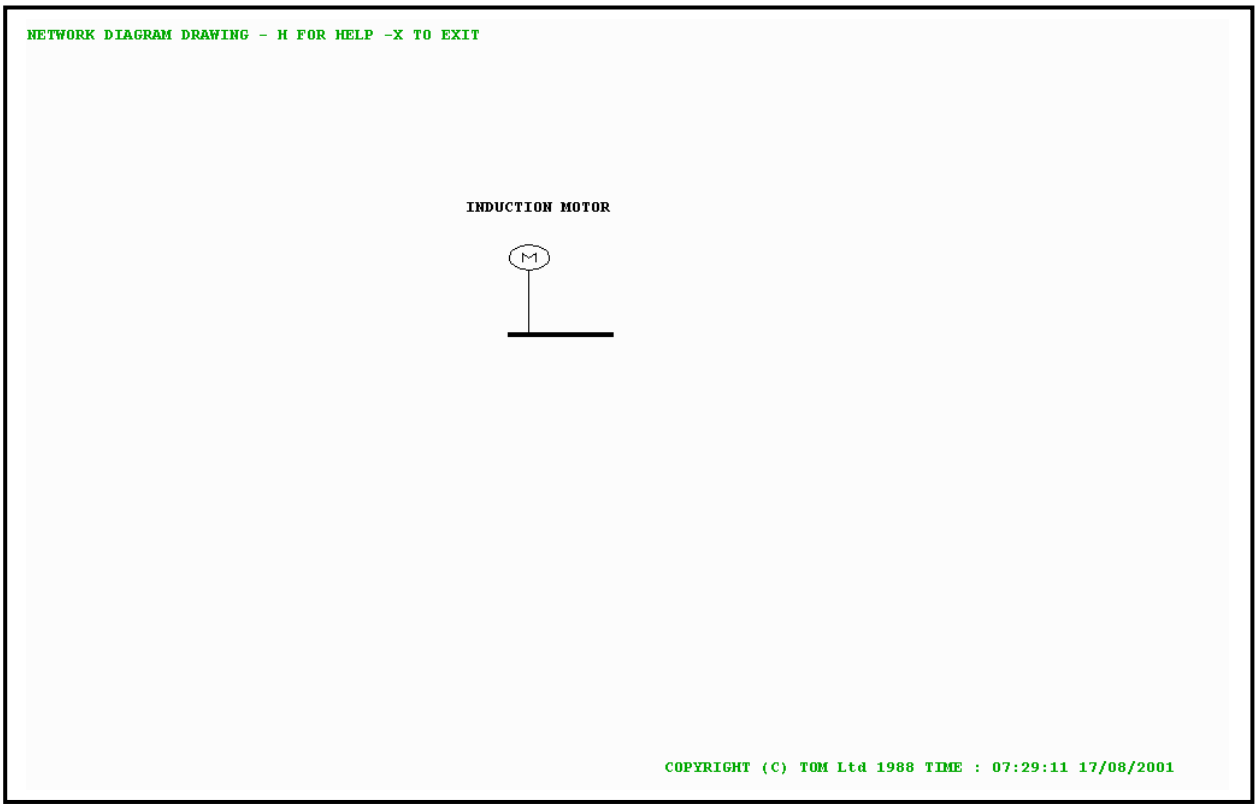


Figure 3-6

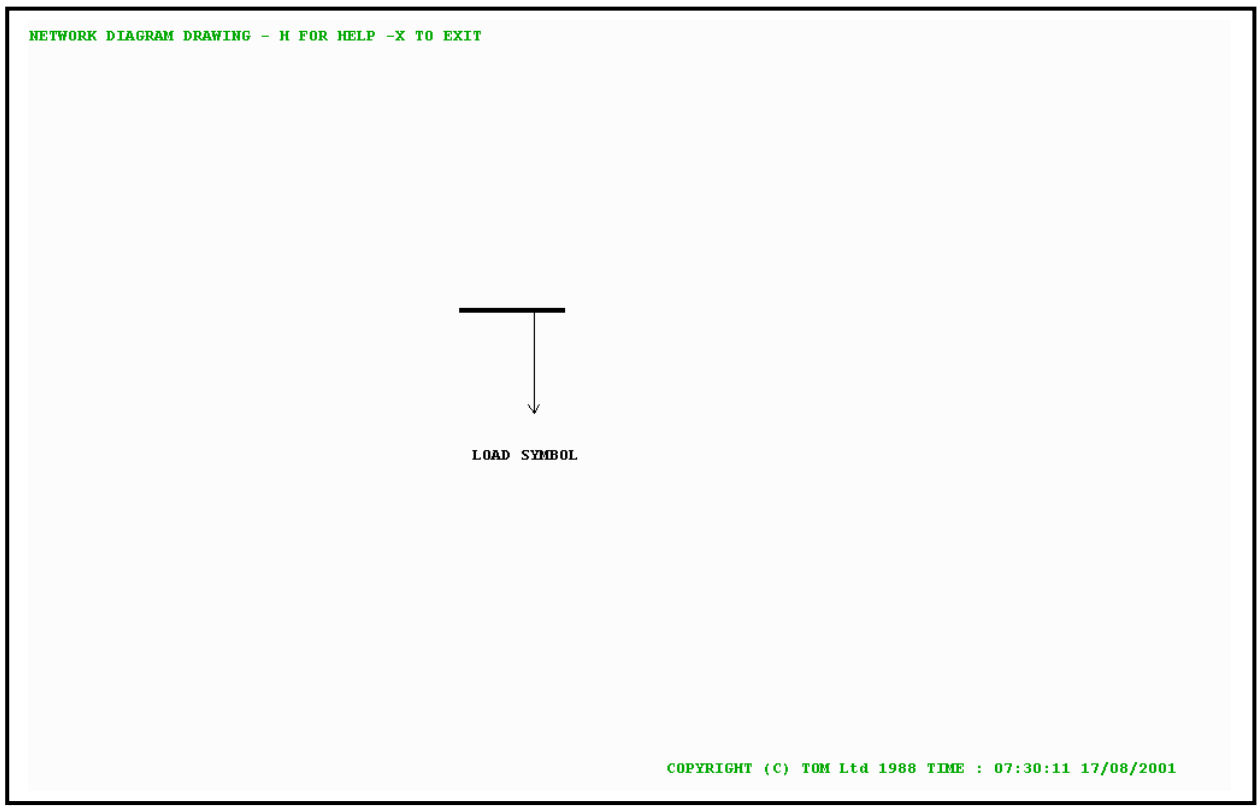


Figure 3-7

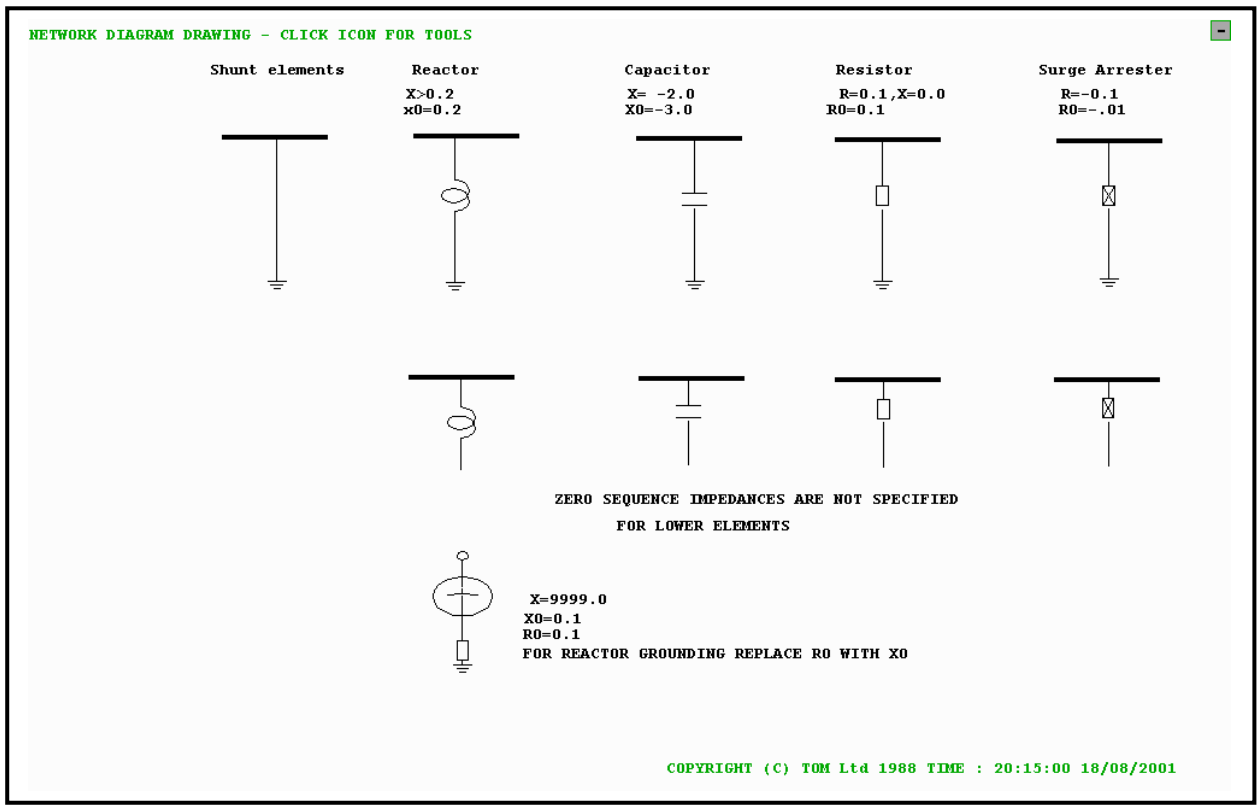


Figure 3-8

3.2.3 Interconnection elements

Connections between substations and/or junctions are drawn using any one or combination of the connection keys, <A>, <C>, <R>, <T>, <Q>, and<%>. Each key functions in essentially the same way but draws a different in-line plant symbol, e.g. the <T> key draws an in-line transformer symbol as part of the connection line. It is therefore possible to explain the connection procedure by only considering in detail one of the connection keys. The <C> key draws a connection line that includes no in-line plant, and is used here to describe how a connection can be made.

Also included in this section is the in-feeding transformer element, which is a special type of interconnection element to which the following sections on interconnection do not apply. It is described in this section to conform to the format of this manual.

3.2.3.1 The connection process

The connection process functions by drawing a connection line from the last selected substation, junction or the last 'unterminated connection segment' end-point, to the current cursor position. To illustrate this, consider figure 3.9, which shows a diagram in which only one substation has been drawn. This is situated at position (a,b). The cursor is positioned at (x,y). In order to draw a connection line to this point the user presses the <C> key. Figure 3.10 shows the connection, which is left unterminated, and is hence called an unterminated connection segment.

If the cursor is now moved to (v,w) and a <C> typed again another connection will be drawn to point (v,w) from point (x,y), as the unterminated segment at (x,y) is used as the starting point of the new connection segment. This segment is also unterminated as shown in figure 3.11.

This drawing of unterminated circuit segments can continue indefinitely, but obviously the user will ultimately wish to terminate the connection, i.e. connect it to either a sub-station or junction. To do this he simply positions the cursor at the point at which the substation (or junction) has to be drawn and types an <S> or <J>. The program then draws a substation symbol (or junction) and also draws a new connection segment that terminates at the substation (or junction). This is shown in figure 3.12; the cursor is positioned at (t,u) and an <S> is pressed, the program draws the substation symbol at (t,u) and also draws a connection line from (v,w) to the substation.

This automatic termination does not require that a new substation (or junction) symbol be drawn but will also occur if the cursor is positioned over an already existing substation (or junction symbol and the <C> key pressed. Figure 3.13 shows an example of this. The connection line ends at point (a,b) and an already existing substation lies at (x,y). The cursor is positioned at point (x,y,) and an <C> key is pressed. The resulting connection line is shown in figure 3.14.

In general it can be said that whenever an unterminated connection segment exists the next depression of either the <S> or <J> keys will terminate or close the circuit by connecting it to the substation (drawn or not drawn) at the current cursor position.

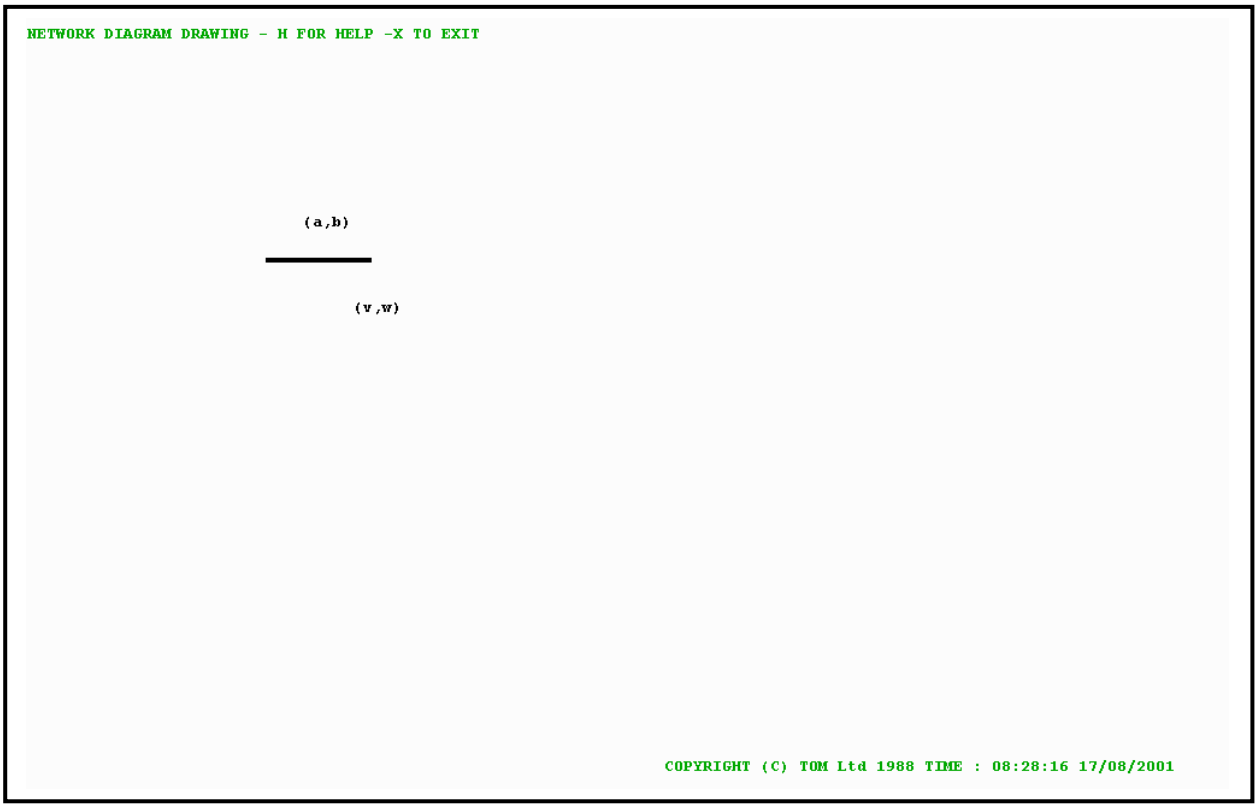


Figure 3-9

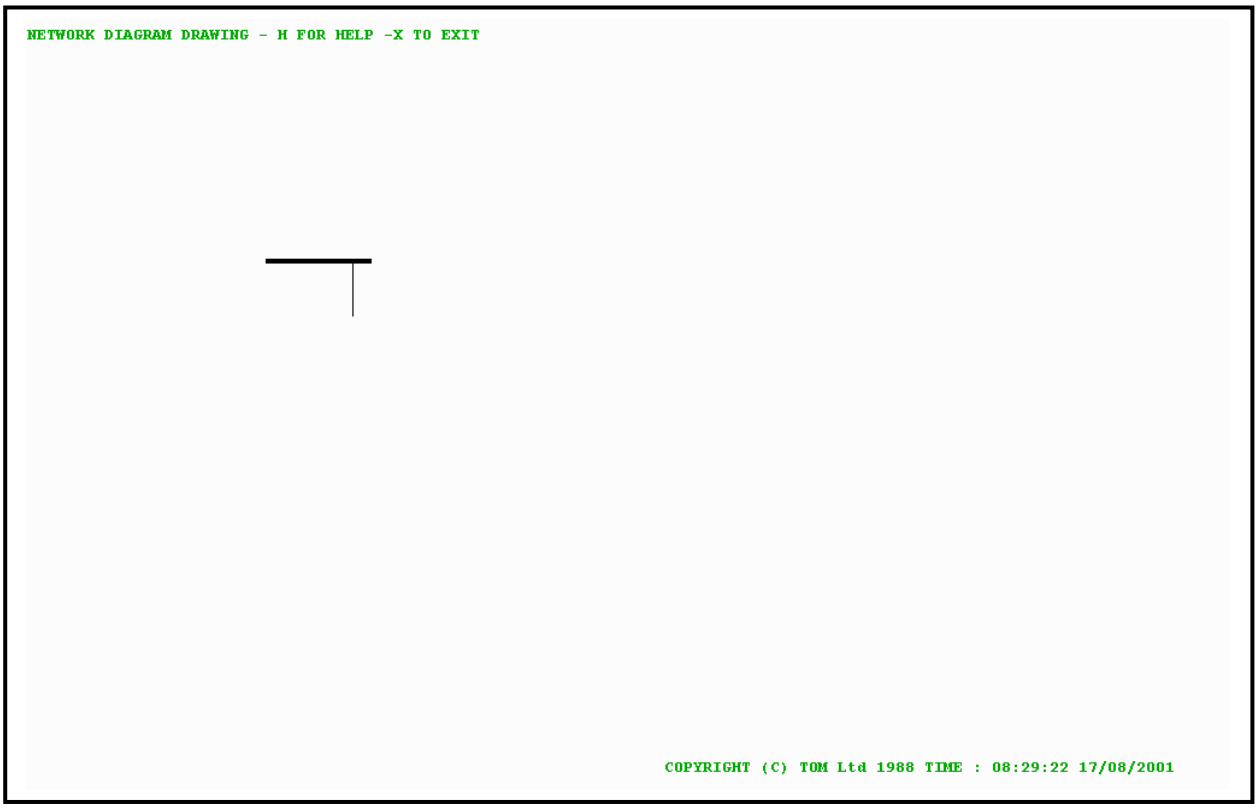


Figure 3-10

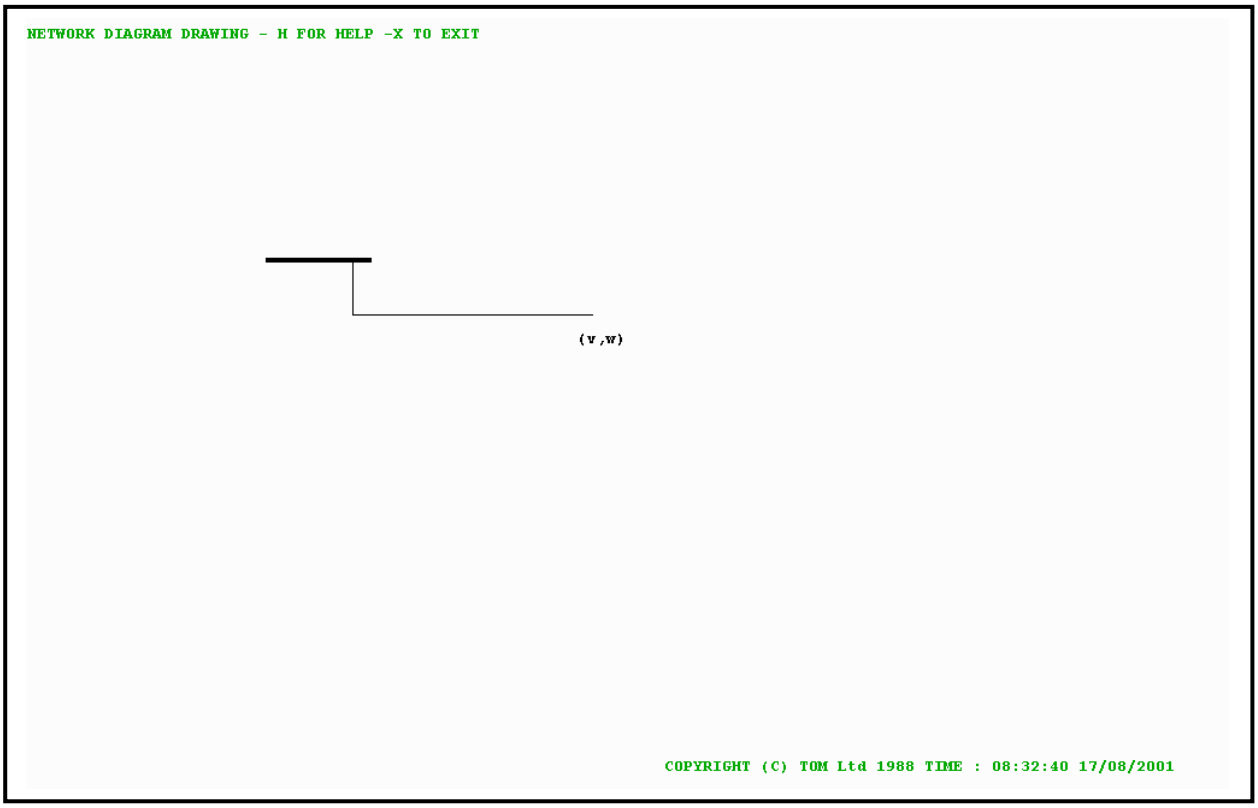


Figure 3-11

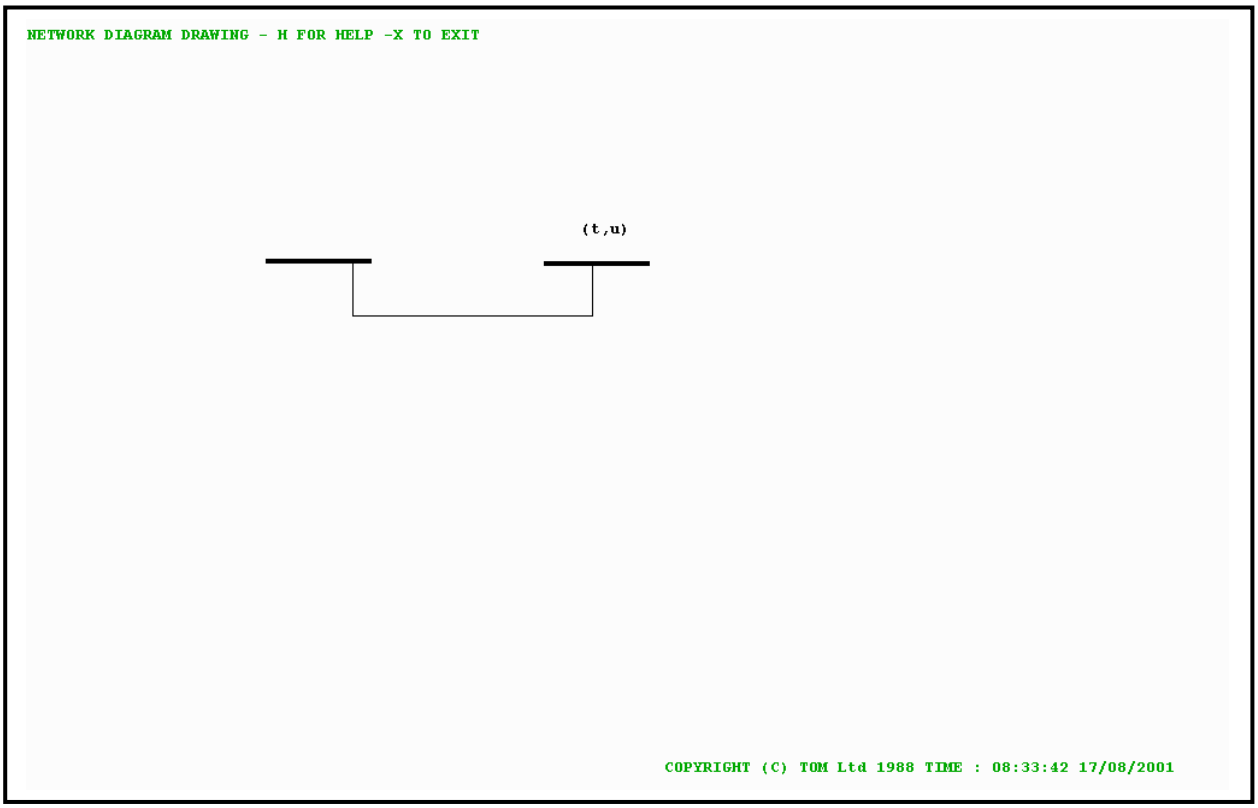


Figure 3-12

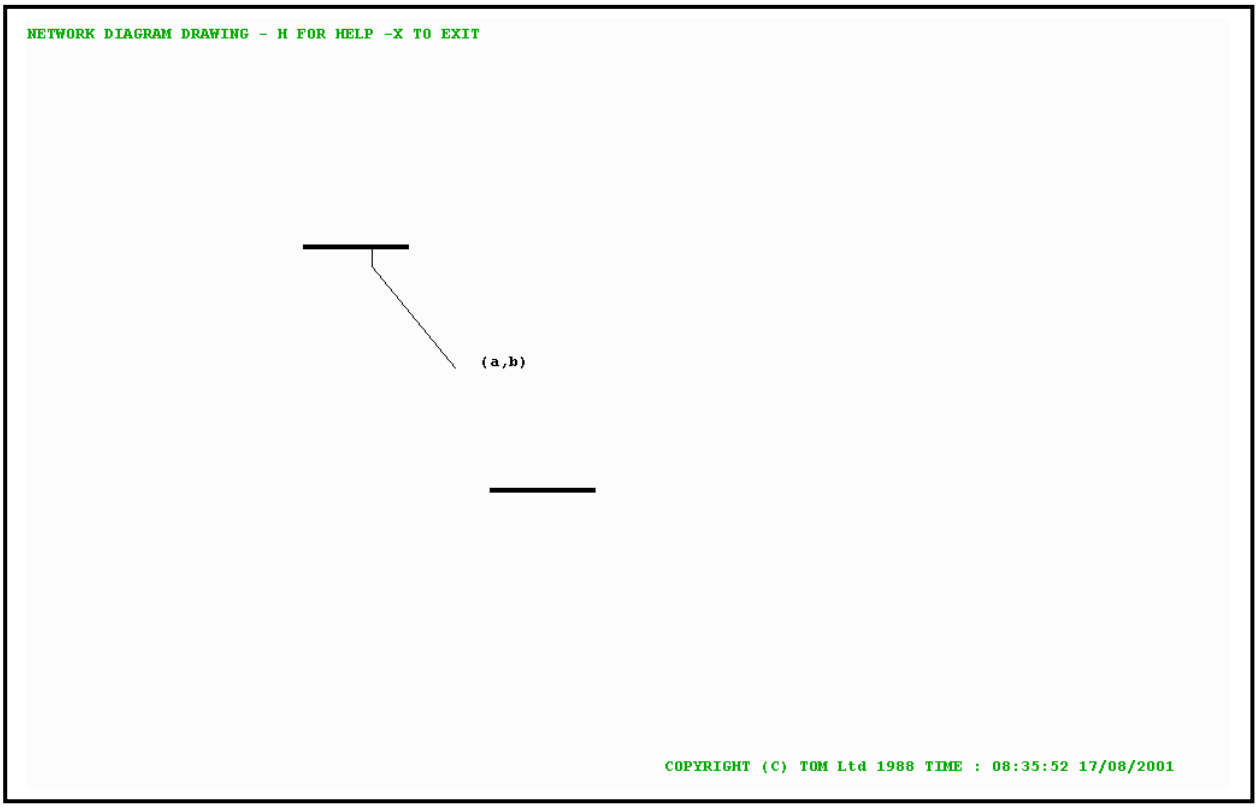


Figure 3-13

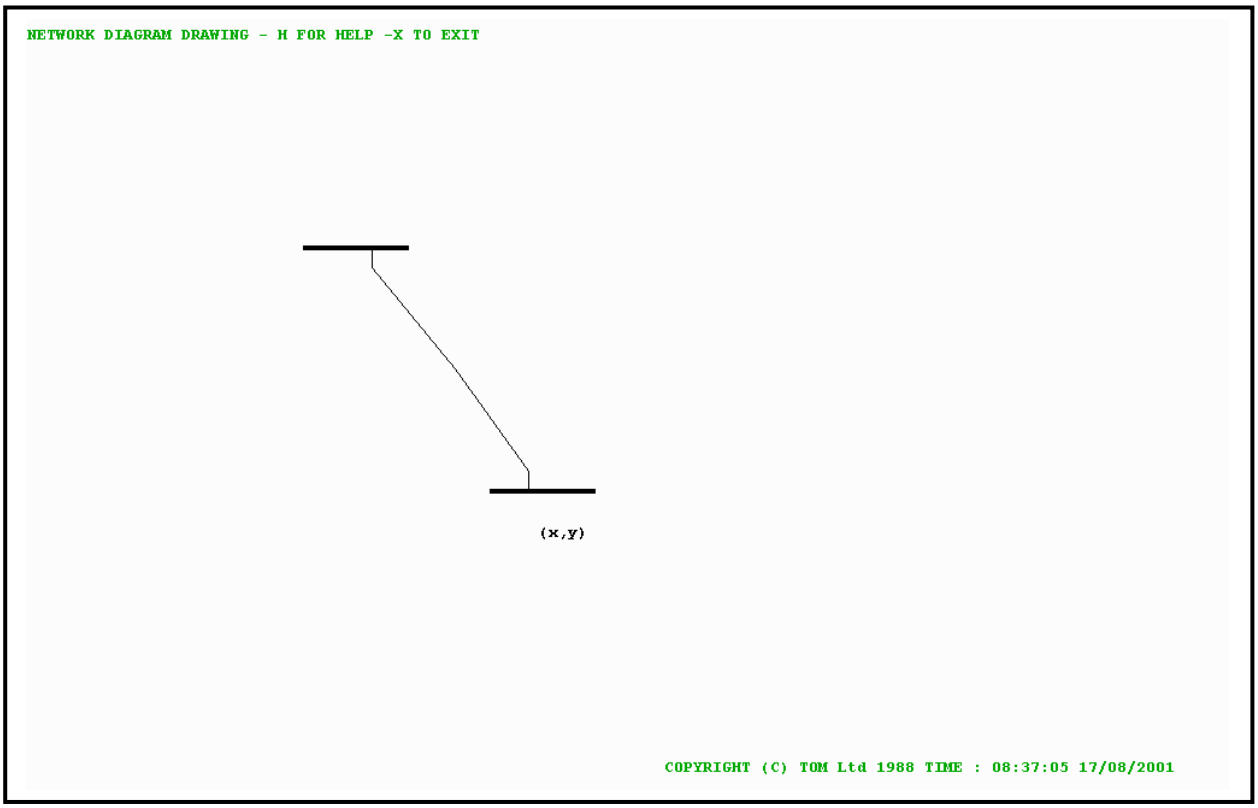


Figure 3-14

3.2.3.2 Connecting with a single connection segment

When only one connection segment is required between two substations, the connection procedure is very simple but the steps are different depending on the order in which the substations were drawn, i.e. either

i. the last but one drawn or selected substation is to be connected to the current one
ii. other substations were drawn in between the two to be connected.

If condition (i) exists then all that is required to make the connection is to type the <C> key when the cursor is positioned over either substation.

If condition (ii) exists, it is first necessary to revert to condition (i), i.e. set the last but one substation to be the one to be connected from. This is done by placing the cursor over the substation and typing <S> (this makes this the current substation), moving the cursor over the other substation and typing a <C> to draw the circuit.

To illustrate these two connection procedures consider figure 3.15. This shows two substations, one situated at (a,b) the other at (x,y).

If condition (i) exists the connection procedure is:- position the cursor at (x,y) and press <C>

If condition (ii) exists:- position the cursor at (a,b) and press <S>
- position the cursor at (x,y) and press <C>

The result of either of these is to draw a circuit as shown in 3.16.

The same process as described above in section 3.2.3 may be used with selecting elements from tool bars as stated in section 3.1. In this case just select circuit symbol instead of pressing <C> and just select substation symbol instead of pressing <S>.

Note also that in the above expressions the <S> key must be replaced with <B> if busbar (vertical substation) have to be drawn or selected instead of substation. **Note also that in contradict with radial plants, a click on a substation, busbar, or junction after selecting circuit from the tool bars will not cause the substation to be selected. This means that the sending end substation must had been selected before initiating the circuit drawing.**

3.2.3.3 The connection keys

As was mentioned above each of the connection keys functions exactly as the <C> key described above, except that an in-line plant symbol is included.

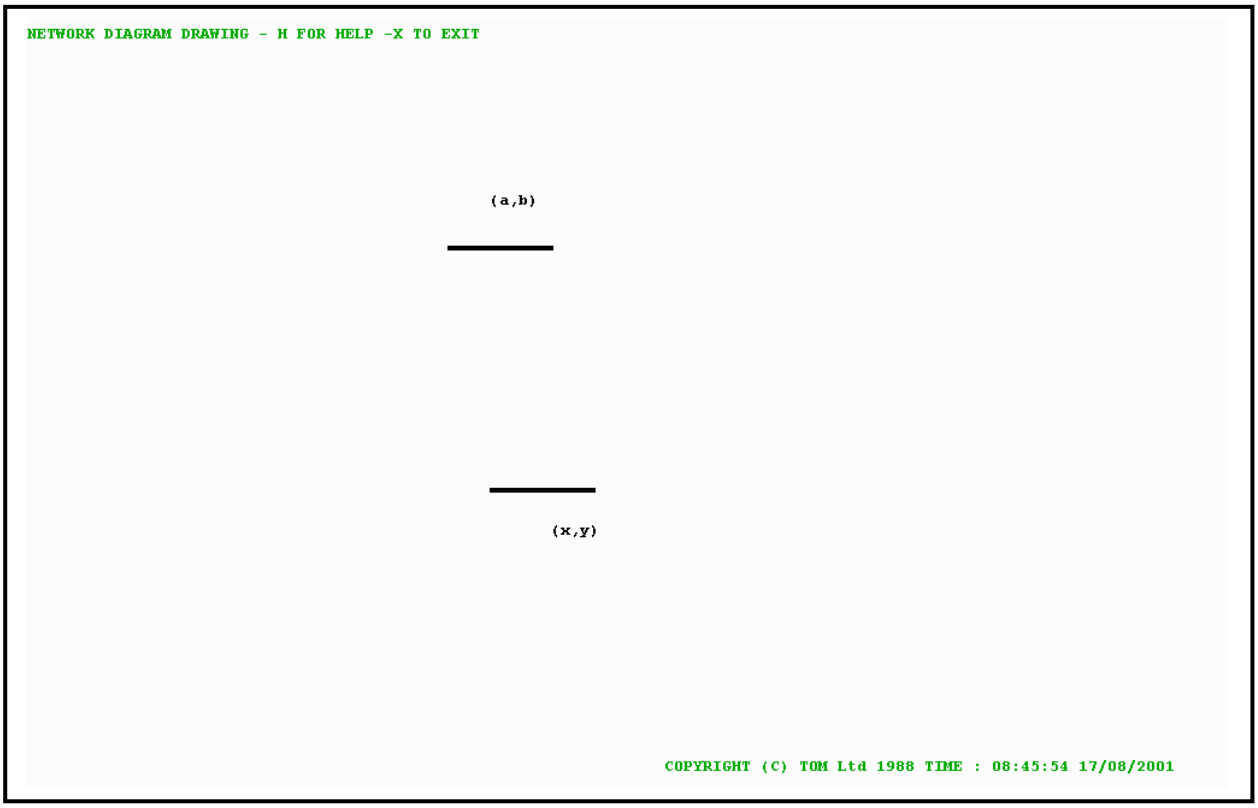


Figure 3-15

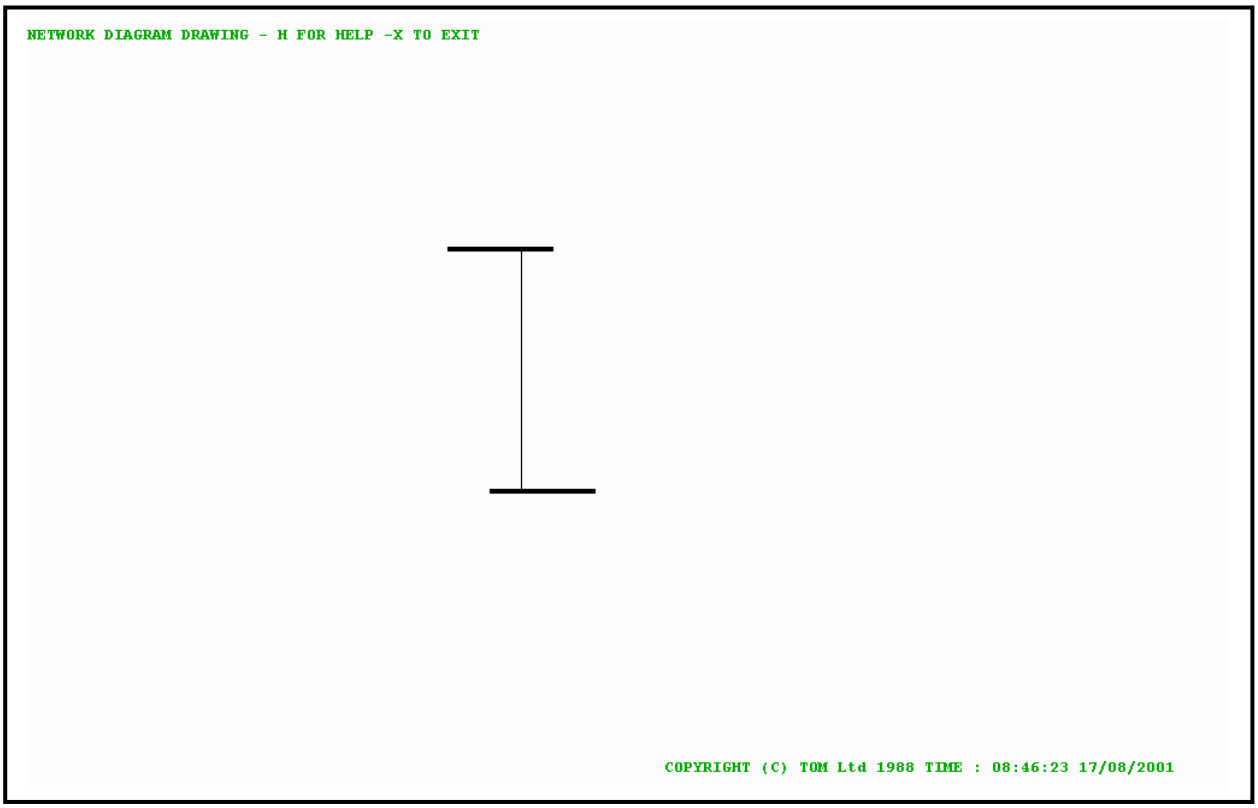


Figure 3-16

The <A> key

Draws a connection line including an auto transformer symbol. This is shown in figure 3.17. See also <T> below.

The <C> key

Draws a simple connection line as discussed above.

The <R> key

Draws a connection line including a reactor symbol. This is shown in figure 3.18. The reactor will be replaced by a series capacitor if its impedance is negative (shown also in figure 3.18).

The <T> key

Draws a connection line including an in-line transformer symbol. This is shown in figure 3.19. The tapped winding is always positioned at the starting (sending) end of the connection. If you press <Shift F6> or <Shift F8> before pressing <T> or <A> key three windings transformer can be built. This is shown in figure 3.20 and described in the following section.

Three windings transformer

<AltF6> (in dos and unix platform) / **<ShiftF6>** (In Windows platform) Before <T> or <A>, draw a three winding transformer
<AltF8> (in dos and unix platform) / **<ShiftF8>** (In Windows platform) Before <T> or <A>, draw a three winding transformer symbol reverse direction

In order to draw three windings transformers one must follow the following process:
1. Draw the primary side substation or busbar or junction
2. Draw the secondary side substation or busbar or junction
3. Select again the primary side substation or busbar or junction
4. Locate the mouse cursor in the secondary side substation or busbar or junction
5. Press three winding transformer symbol as described above
6. Type key <T> or <A>
7. Computer draws a three windings transformer while its territory is not connected
8. Draw a substation or busbar or junction for territory side, computer connects the territory
9. You may modify the connections using usual keys described in section 3.5.

Note that: PASHA represents three windings transformer as three branches between the surrounded busbars. The center point represents as junction. This junction is specific for three windings, i.e. if you delete a branch and draw that branch again the computer knows that it is a branch of three windings transformer and therefore it represent it as a one leg of three windings transformer. In this regard you may delete a leg, which is represented as circuits, and replace it with a transformer. The difference is that in the new leg you may change tap settings. By default a three windings transformer contains three legs and a two windings transformer represents the primary and circuits represent the other legs. You may delete any leg and replace it by another branch as you wish. You may also move (See section 3.5) the junction and the branches to any point. This is shown in figure 3.20.

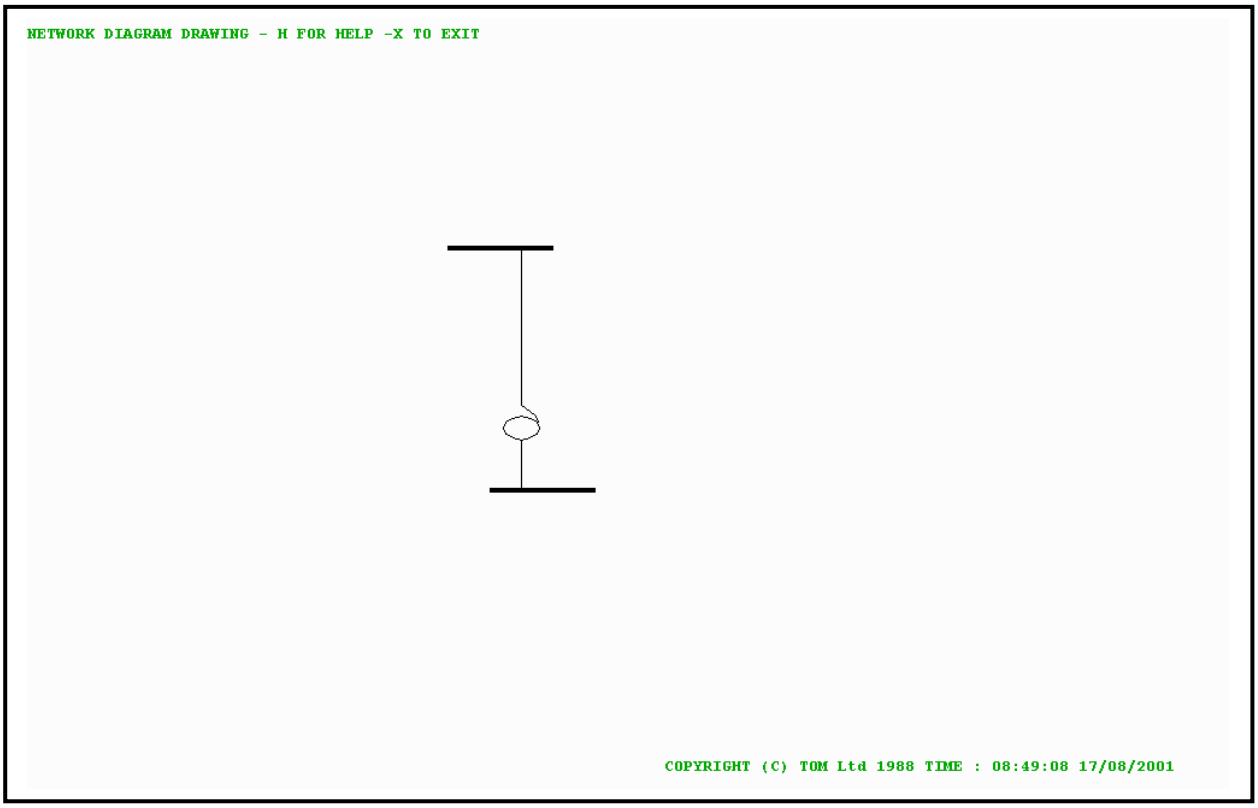


Figure 3-17

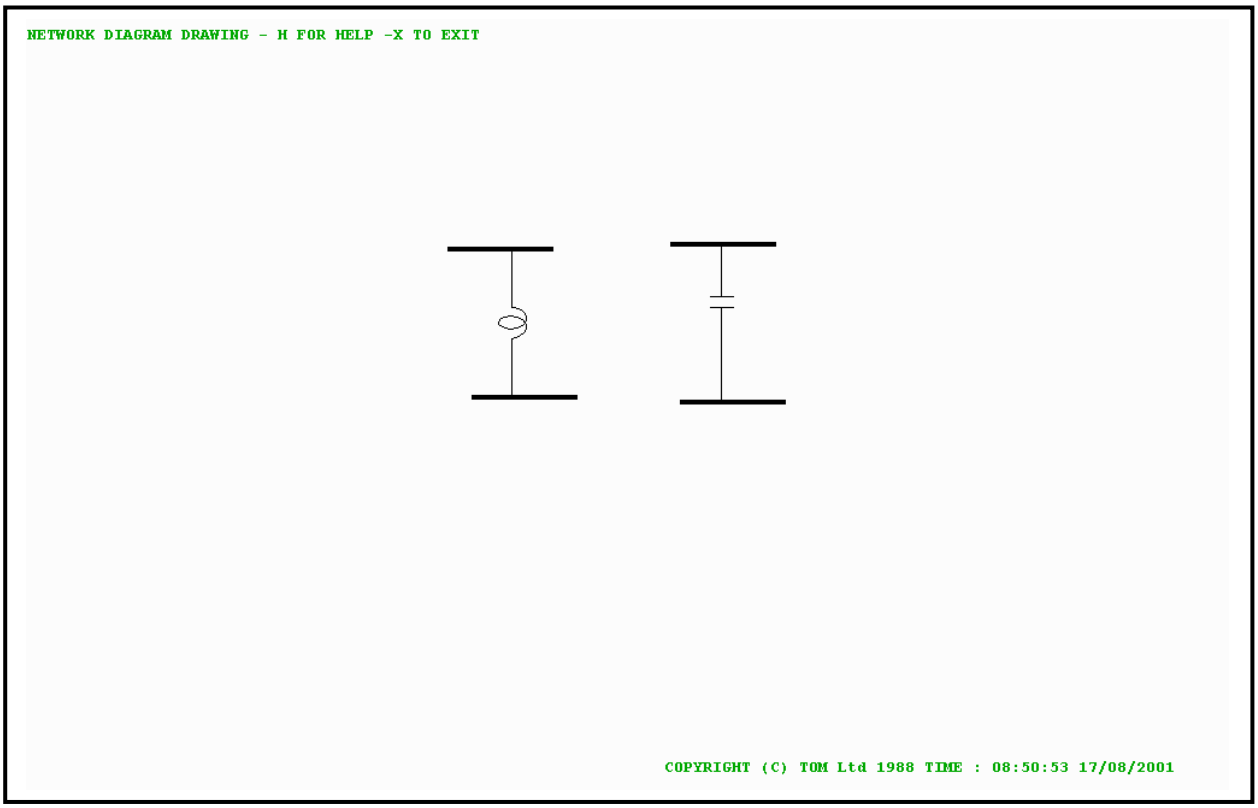


Figure 3-18

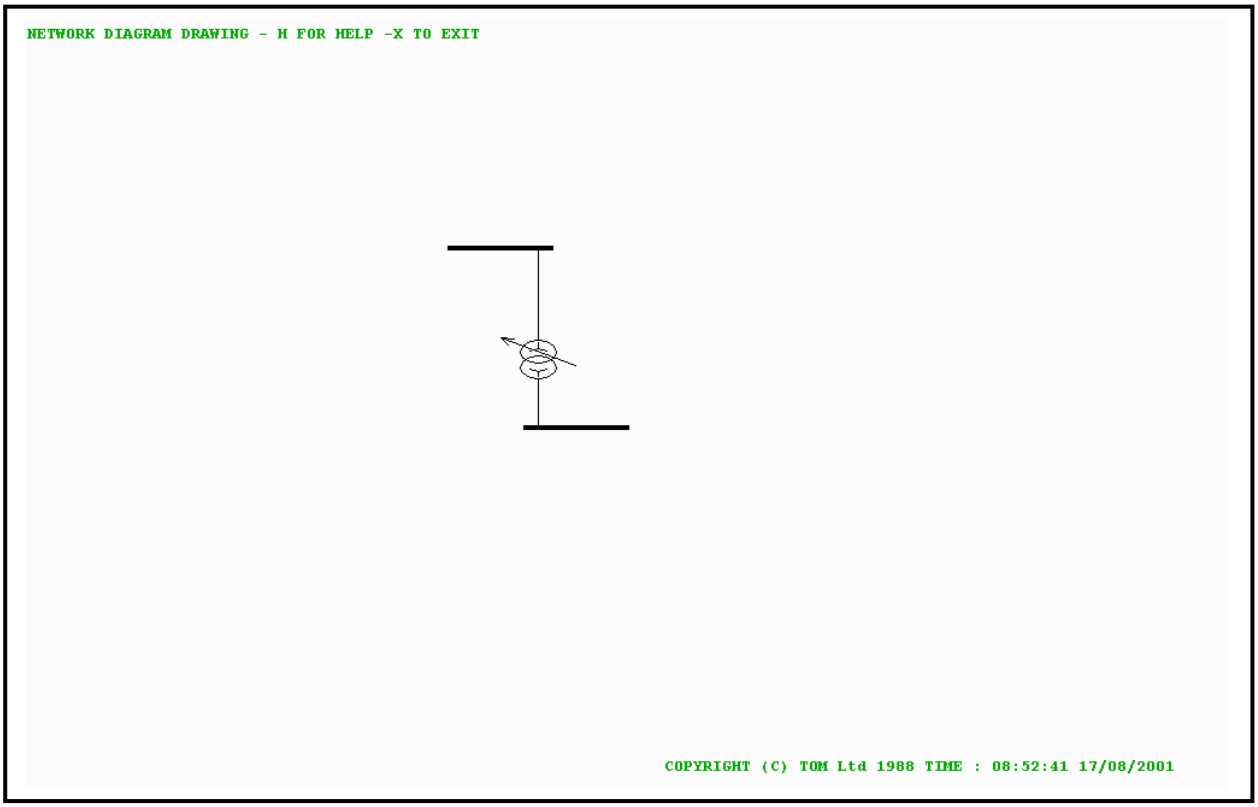


Figure 3-19

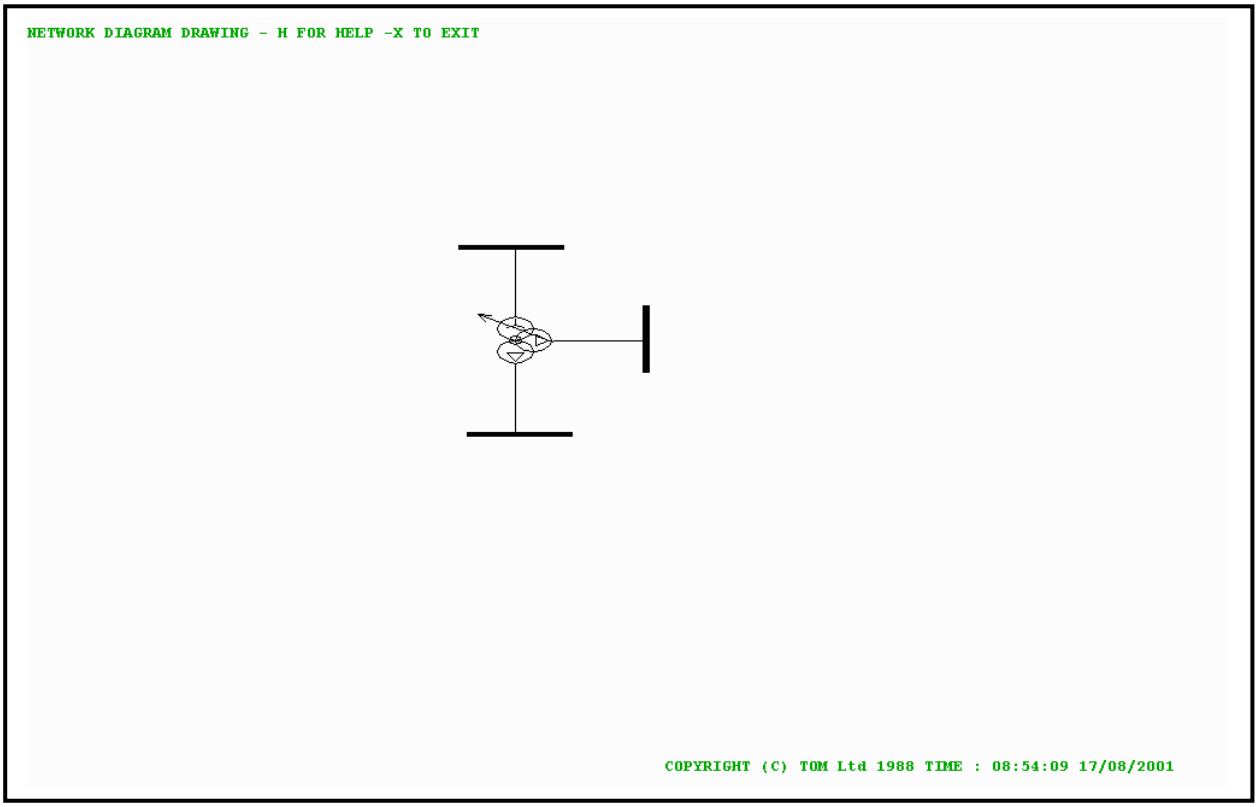


Figure 3-20

3.2.3.4 The in-feeding transformer element

Electrically, the in-feeding transformer symbol represents a straightforward transformer connection between two substations, but in this case the transformer is represented by a W-symbol, with a connecting line to the 'receiving' end busbar only. The connection to the 'sending' busbar is not shown graphically. This alternative transformer symbol is therefore used where the normal transformer or line symbol would lead to congestion in the diagram.

It should be noted that the <W> can not be used in connection sequences as the other connection keys are.

The <W> key

Draws an in-feeding transformer symbol at the cursor position and draws a connection to the previous substation. Figure 3.21 shows an in-feeding transformer symbol connected to a substation.

A message appears at the top of the screen and the message stating that the in-feeding busbar will be 'SOURCE' unless otherwise specified. This means that the program will generate a new substation symbol with a generator as shown in figure 3.22, if the next key you press is an <I> or you may just simply press a click on an already existing busbar. If the latter is the case, and the cursor is positioned over a busbar, then this busbar will be the in-feeding busbar otherwise the computer asks for the name of the busbar.

3.2.3.5 The switch drawing keys

There are two final keys associated with connections that allow switch symbols to be drawn on the previously drawn connection lines. However, these keys are obsolete in the new versions of PASHA. Instead any circuit breaker data entered in Line DATA 6 (See Chapter 4) draws a switch symbol in single-line diagram for that line.

The <1> key: changed to SHIFT<1> and remains just for compatibility (see note)

Draws a switch symbol at the 'sending' end of the last circuit drawn. This is illustrated in figure 3.23.

NOTE: Any branch can have switches drawn at the sending and the receiving end or both. The switches or breakers are better to be entered in Line DATA 6 as sending or receiving end or both.

The <2> key: changed to SHIFT<3> and remains just for compatibility (see note)

Draws a switch symbol at the 'receiving' end of the last circuit drawn. This is illustrated in figure 3.24.

NOTE: Any branch can have switches drawn at the sending and the receiving end or both. The switches or breakers are better to be entered in Line DATA 6 as sending or receiving end or both.

3.2.3.5 Other symbols

The usefulness of drawing elements with keys or selecting from tool bars diminishes when the variety of symbols increases. Instead it is a better idea to draw some of the elements automatically by computer when data is available for them. This will be true if these are related to some of the symbols already drawn. For example, in power system at most two circuit breakers are located in the sending and receiving end of a line. Therefore, whenever a line is drawn, the user may just enter the data for that circuit breaker in LINE DATA 6. The computer will find these data and draw the relating symbols in appropriate places. These types of drawings may be called data dependent symbols. The circuit breakers, fuses, relays, some shunt elements as described before are data dependent symbols.

Please also refer to section 2.5.16 **NOR / DET**. Figure 3.25 shows these symbols drawn by computer in a single-line diagram, please refer to section 4.5.4 for the data needed for shunts in order to the shunt symbol become the symbol as shown in this figure. Please refer to chapter 11 for protection relays and chapter 15 for circuit breakers.

Figure 3.26 shows the protection components one by one.

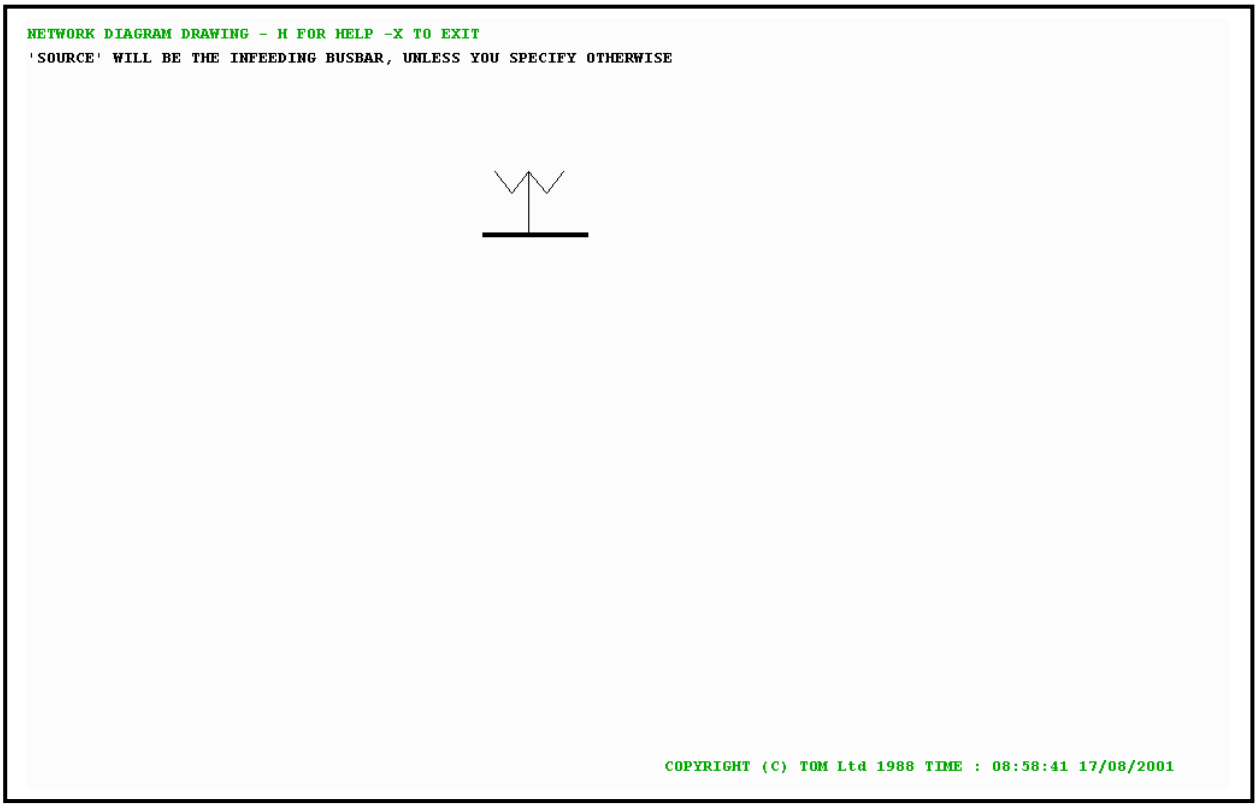


Figure 3-21

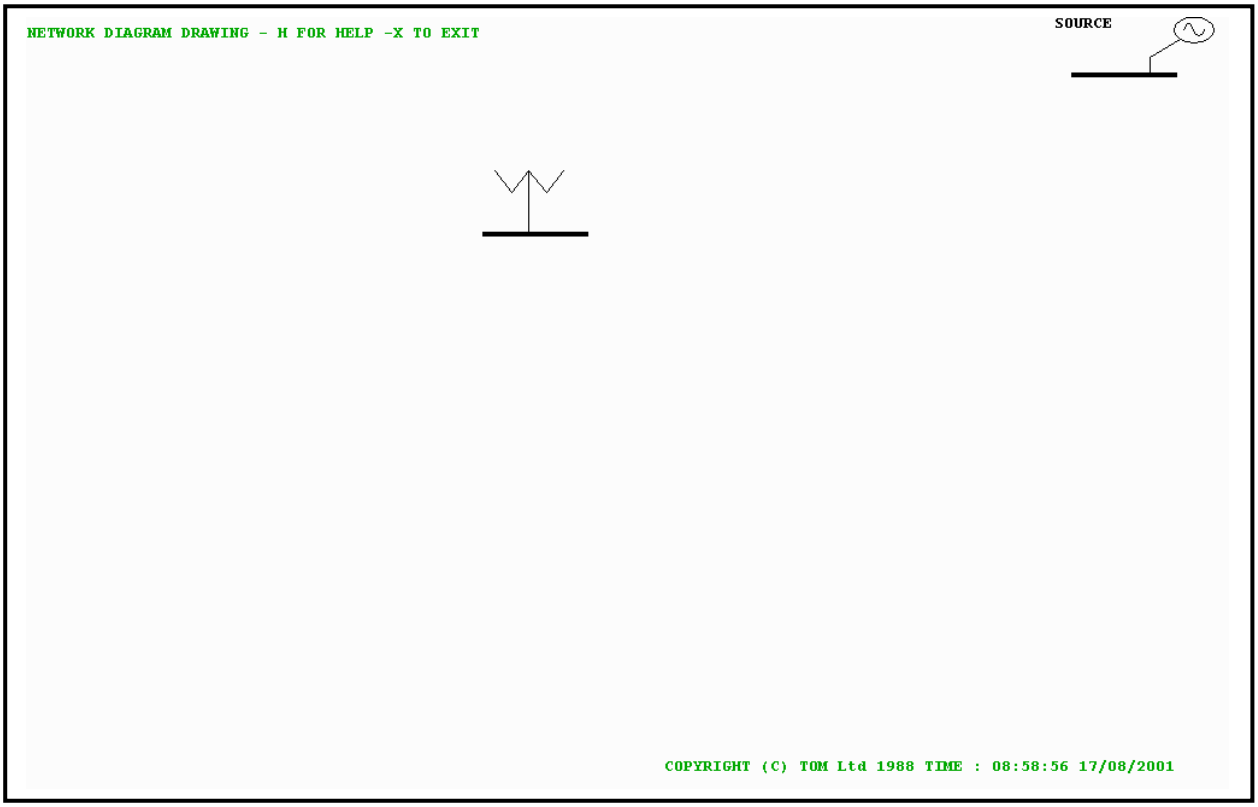


Figure 3-22

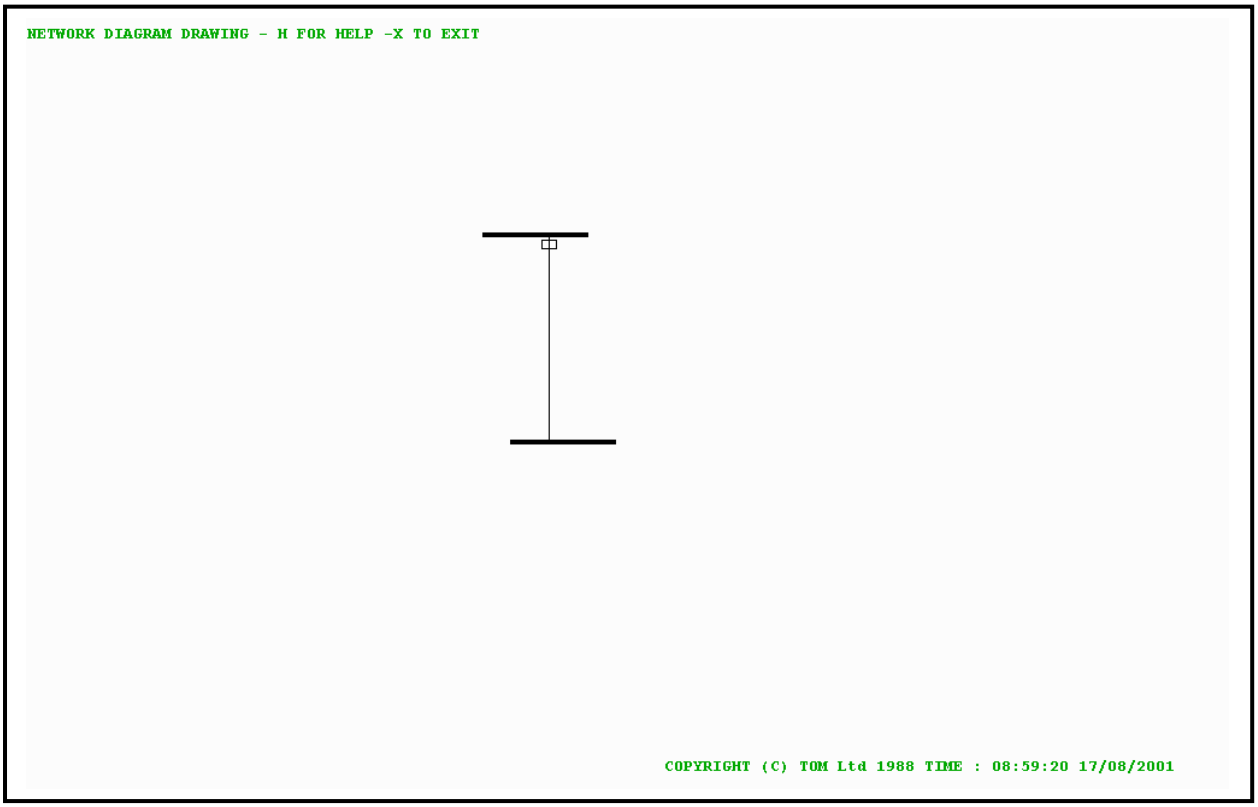


Figure 3-23

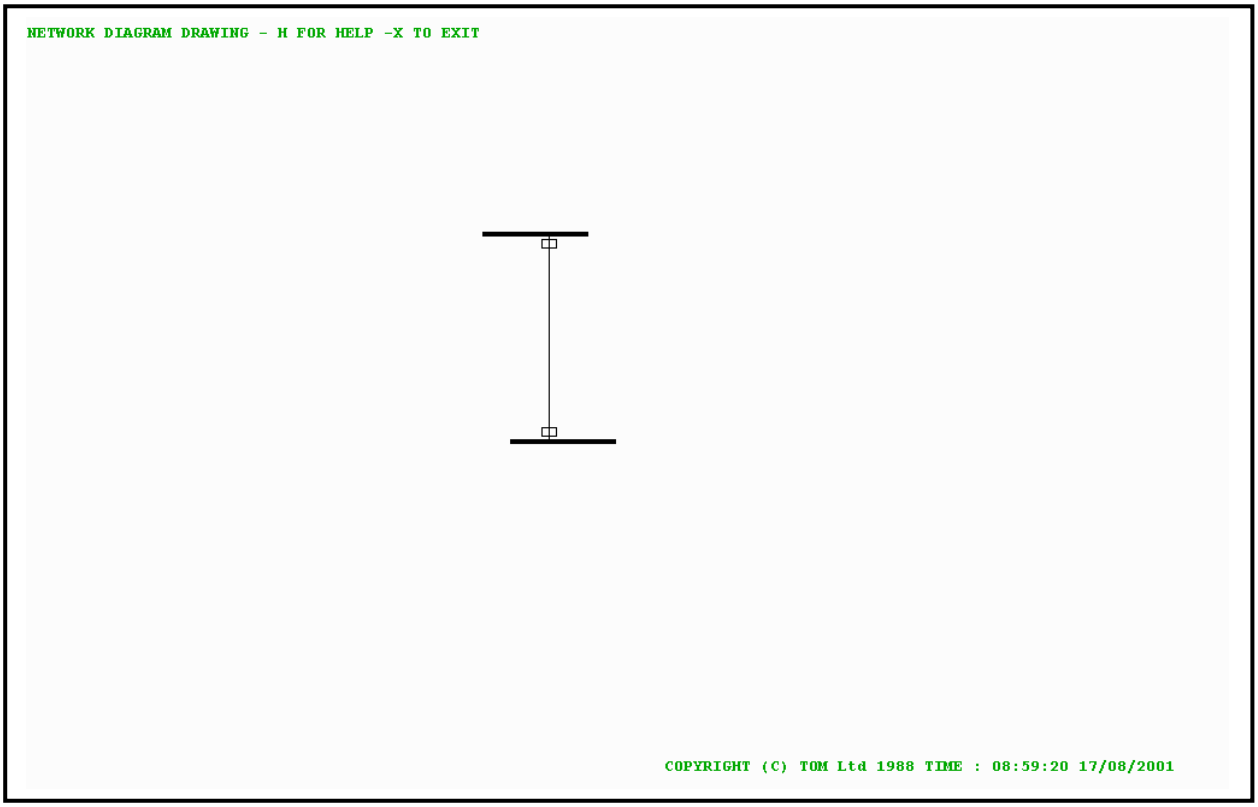


Figure 3-24

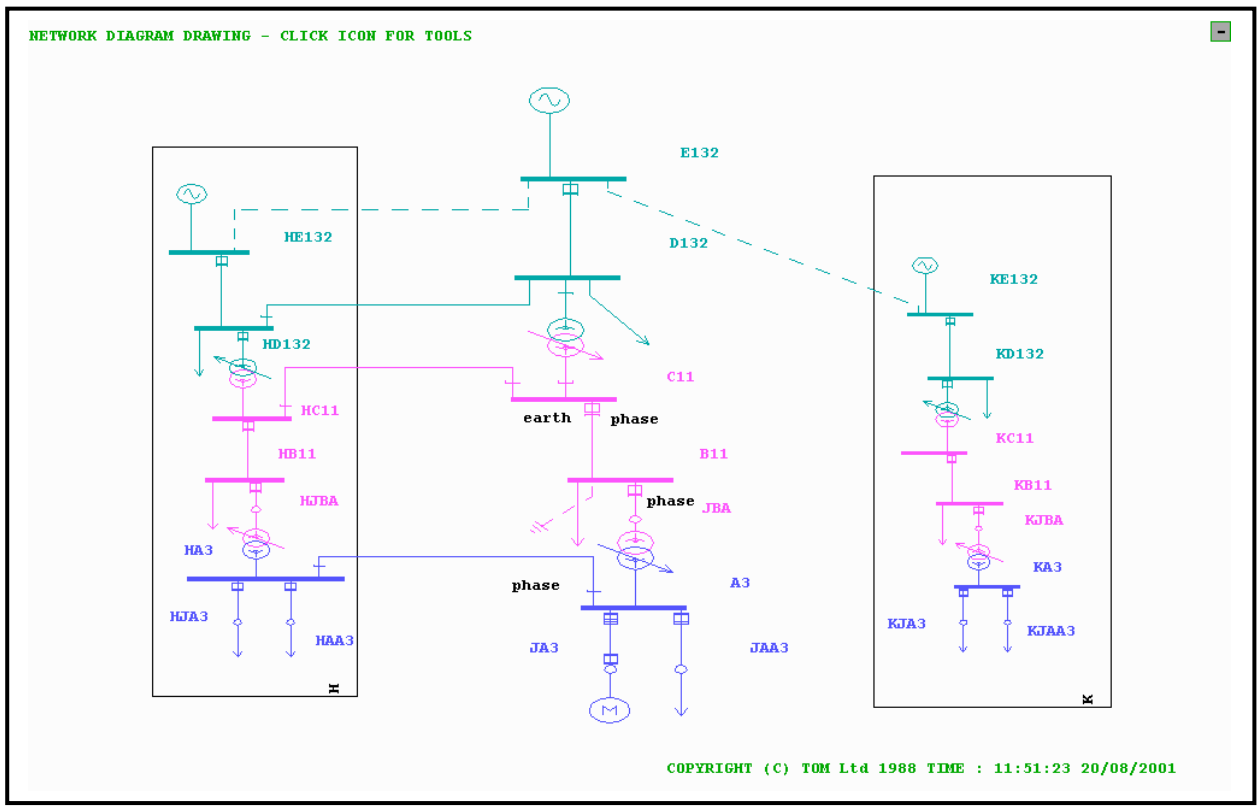


Figure 3-25

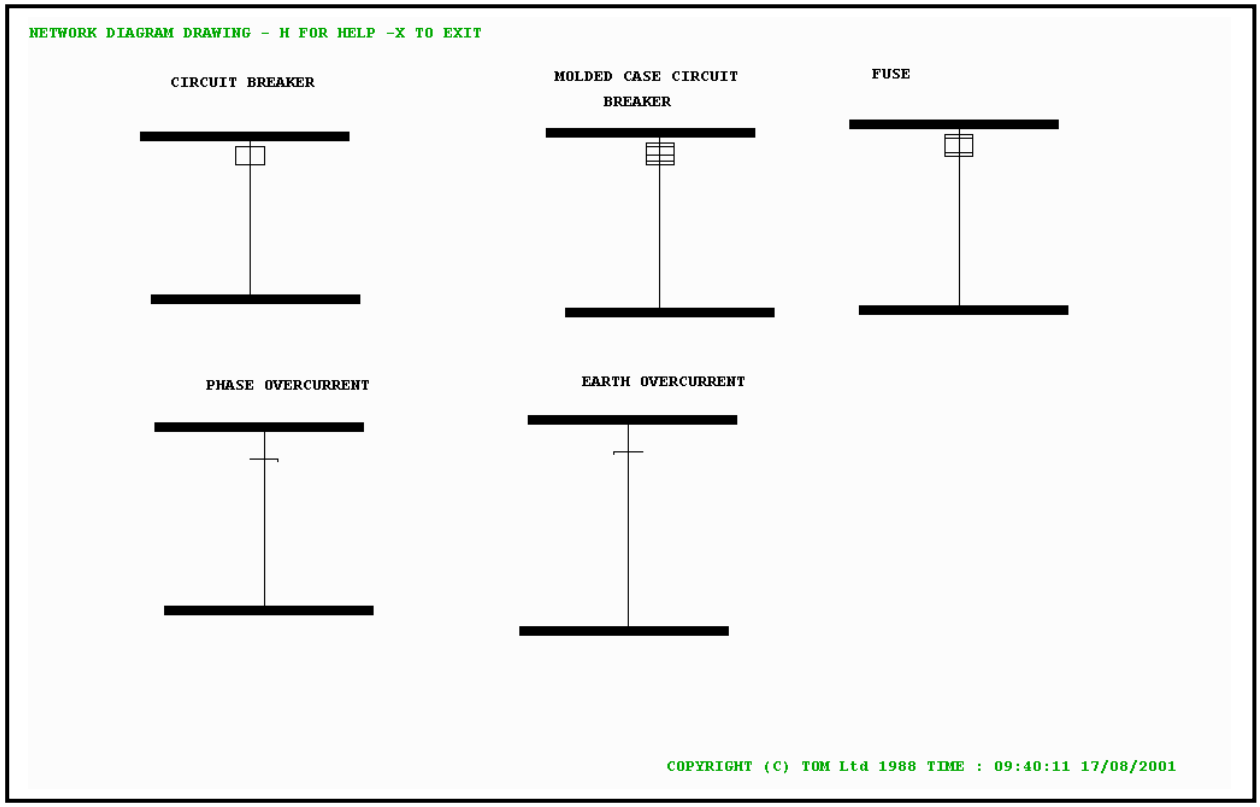


Figure 3-26

3.3 An example of drawing a real network diagram

In order to illustrate exactly how the drawing section of PASHA can be used to draw network diagrams, an example is given here of the drawing process for a simple network.

The example is presented as a set of figures showing each stage of the construction process:

Figure 3.27: The cursor is located at (a,b) and an <S> is pressed to draw substation.

Figure 3.28 A <G> is pressed while the cursor is located at (c,d). A generator is drawn and it connects to substation.

Figure 3.29 The cursor is located at (e,f) and <N> pressed, the name (NETW) is type in.

Figure 3.30: A second substation is drawn at (g,h) by moving the cursor there, and pressing the <S> key.

Figure 3.31: The two substations are connected by then pressing <C> and the cursor remaining at (g,h).

Figure 3.32: This substation is then named by positioning the cursor at (i,j) and typing an <N>. The name is then entered as 'SUB 1'.

Figure 3.33: A load is then drawn off SUB 1 by positioning the cursor at (k,1) and pressing the <L> key.

Figure 3.34: An in-line transformer is then drawn by positioning the cursor at (m,n) and pressing the <T> key.

Figure 3.35: A substation symbol is then drawn at (o,p) by typing an <3>. The unterminated connection segment shown in fig. 3.34 is then automatically terminated at this substation.

Figure 3.36: Three induction motors are then drawn off SUB 1 by positioning the cursor at (k1,l1) ,(k2,l2), (k3,l3) and pressing the <I> keys.

Figure 3.37: The substation has been named 'SUB 2' as above. The cursor is then positioned at (q,r) and the <3> key pressed. A substation symbol is drawn at (q,r) and named 'SUB3'.

Figure 3.38: A connection segment is drawn by re-positioning the cursor over substation 'NETW' and pressing the <S> to select this substation as the start of the connection. The cursor is then moved to (u,v) and the <C> key is pressed.

Figure 3.39: A second connection segment is then drawn by positioning the cursor at (w,x) and again pressing the <C> key. To have exact position it is better to select cross hair on (see section 2.2.2.2)

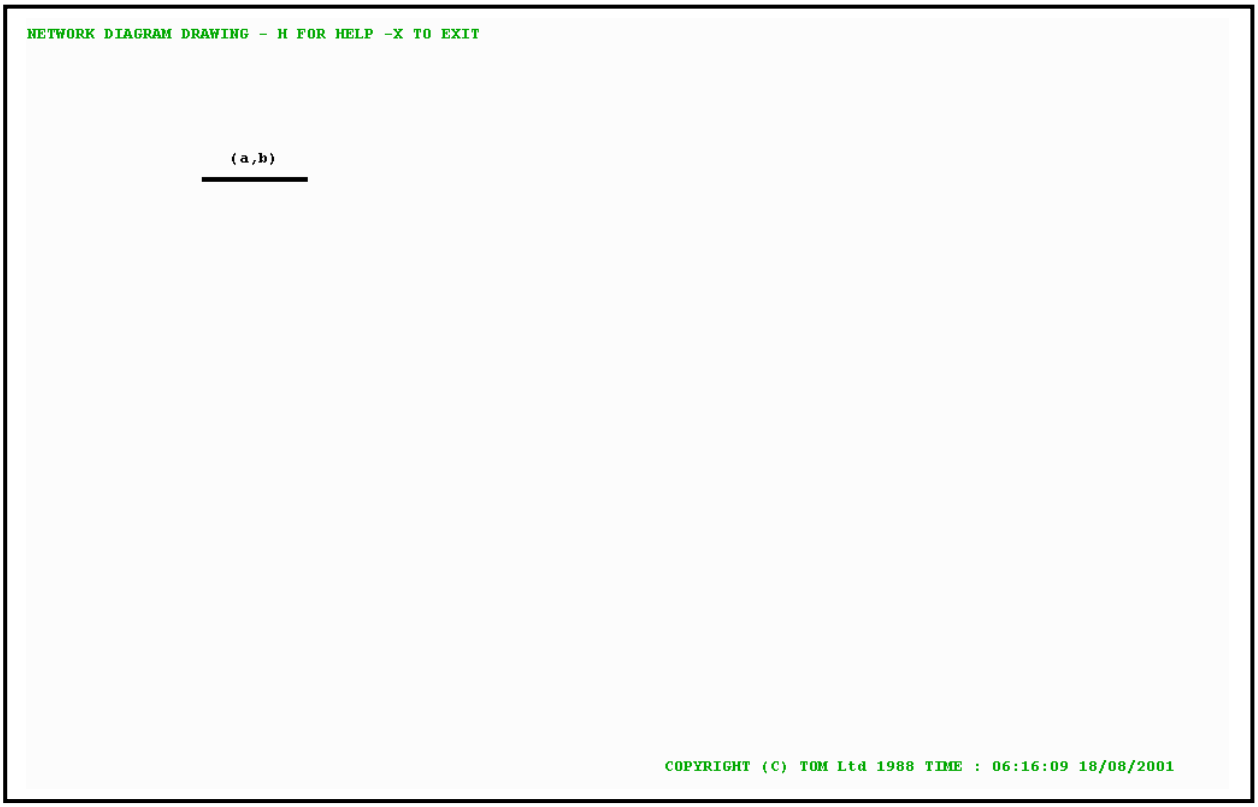


Figure 3-27

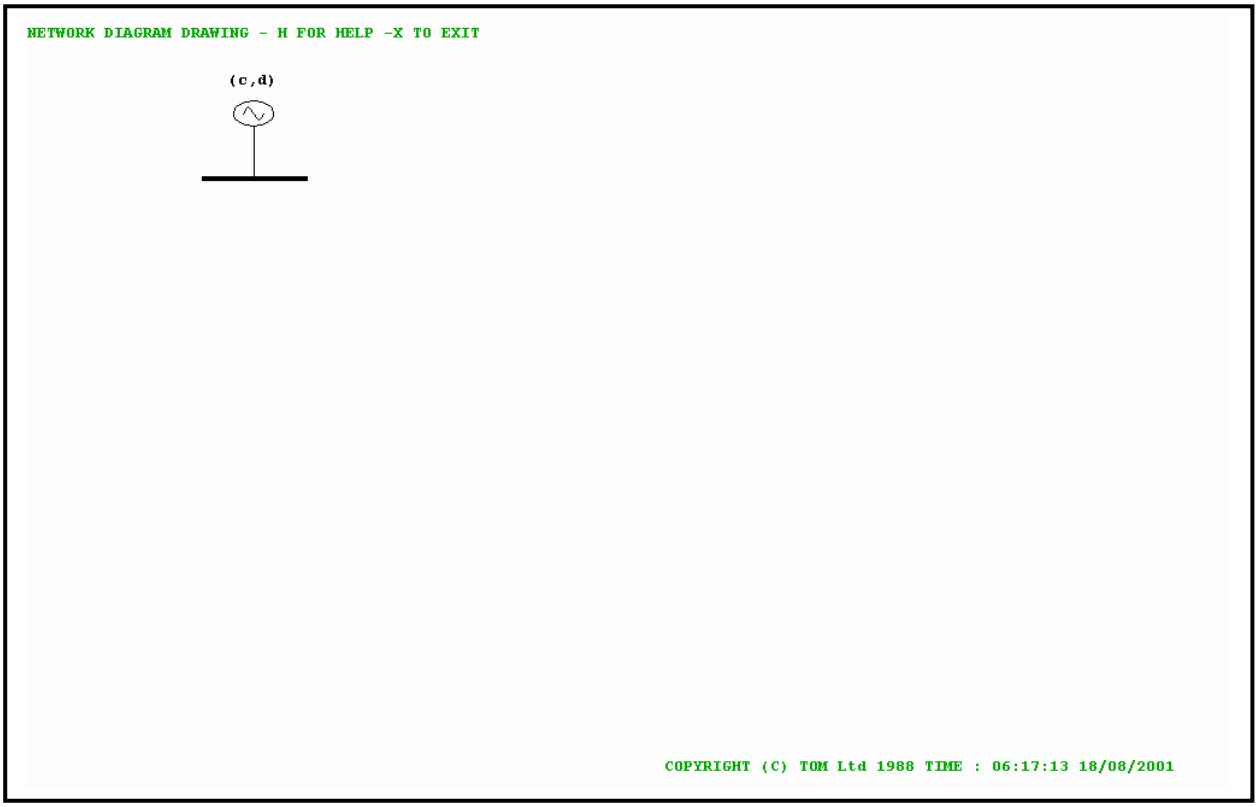


Figure 3-28

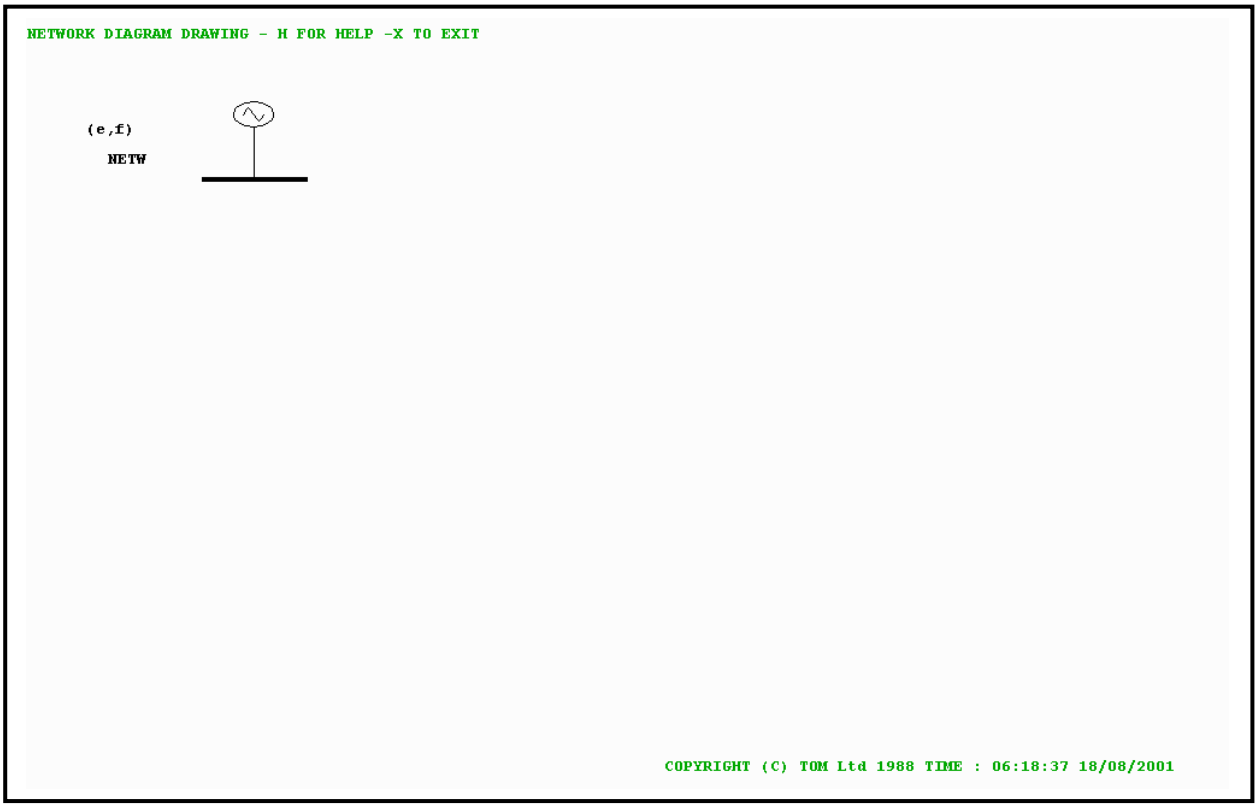


Figure 3-29

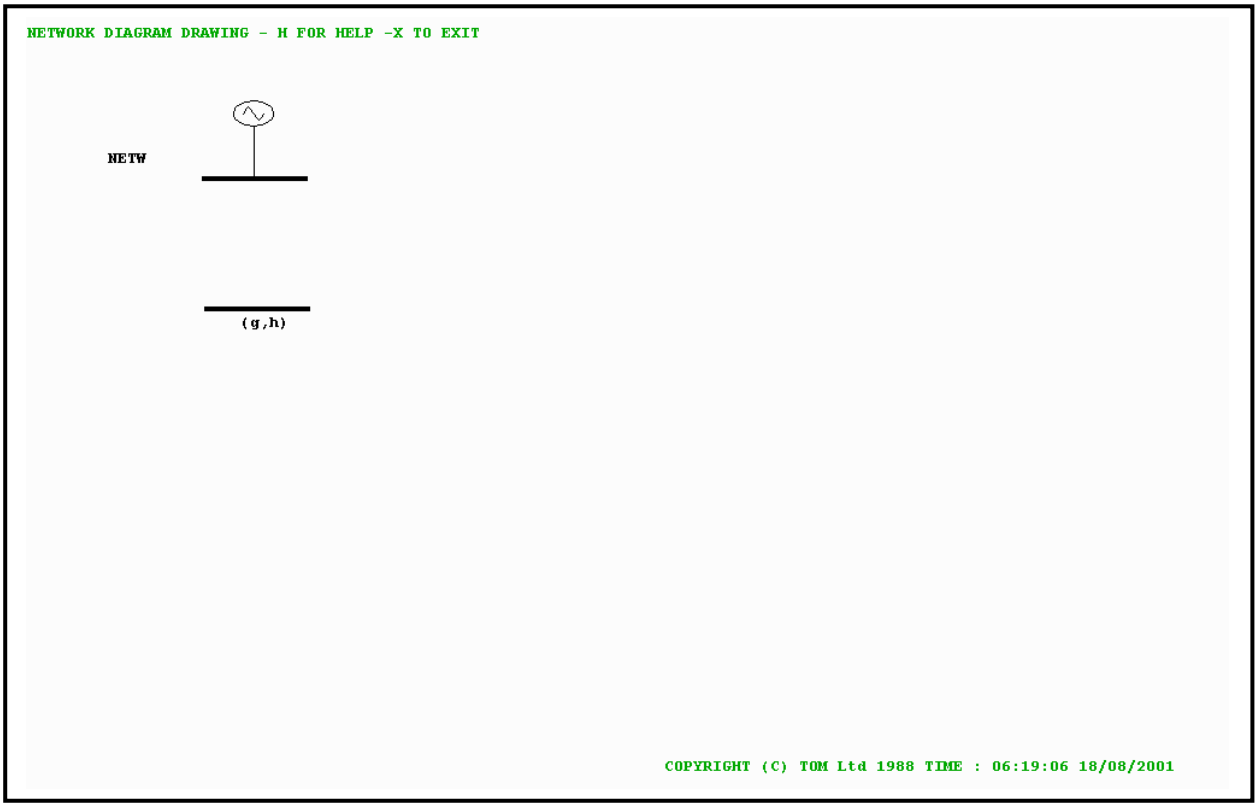


Figure 3-30

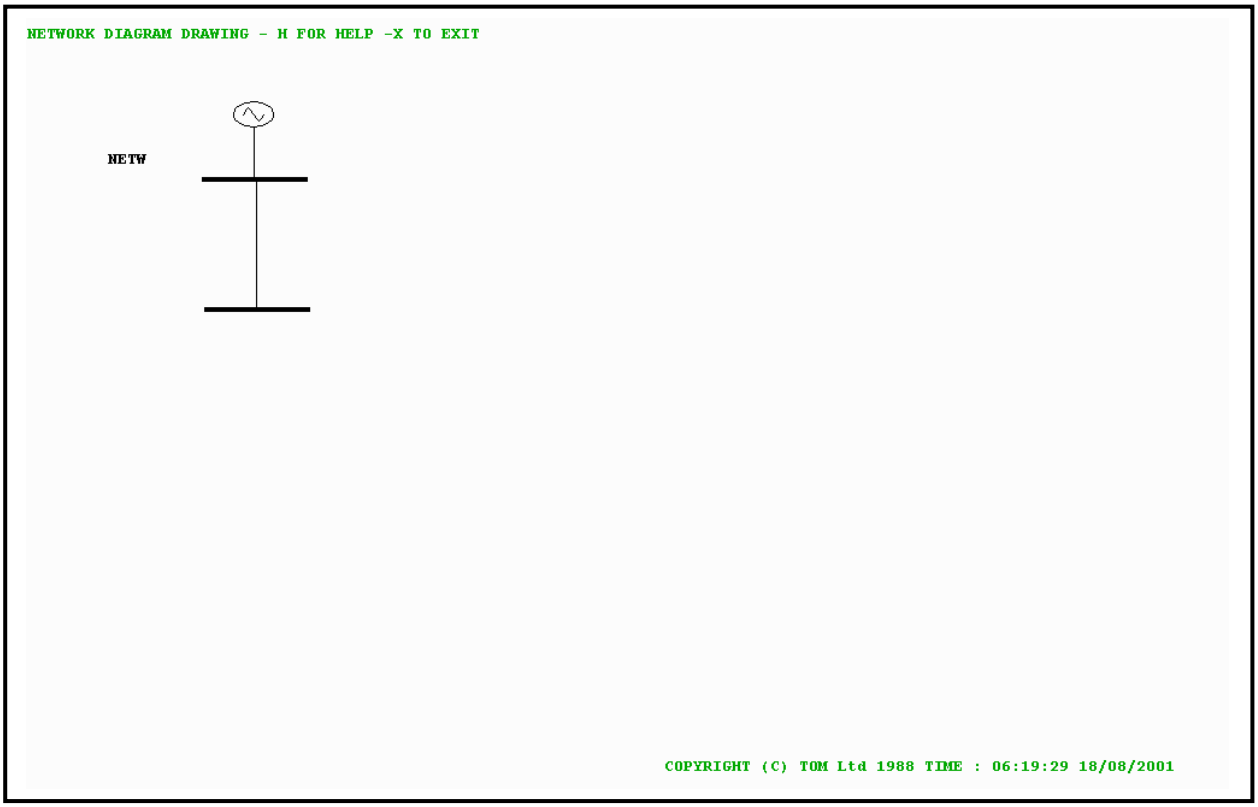


Figure 3-31

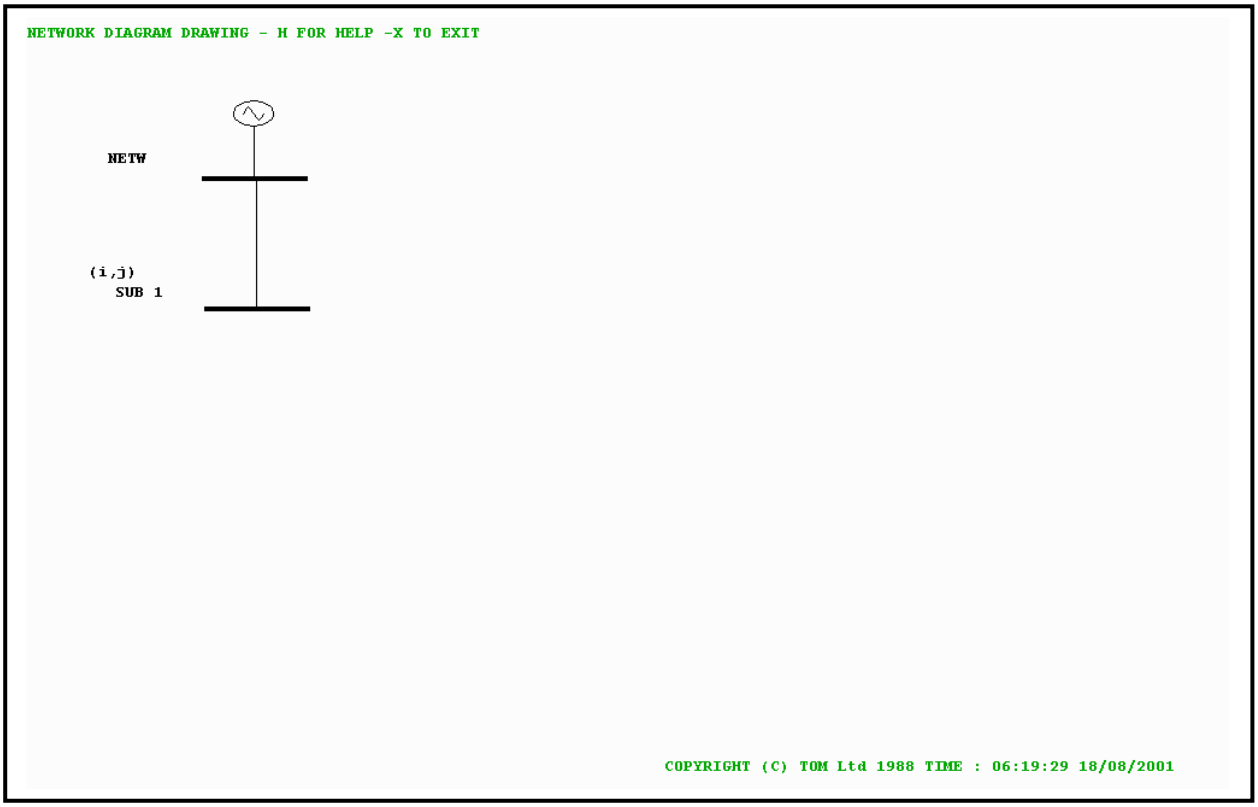


Figure 3-32

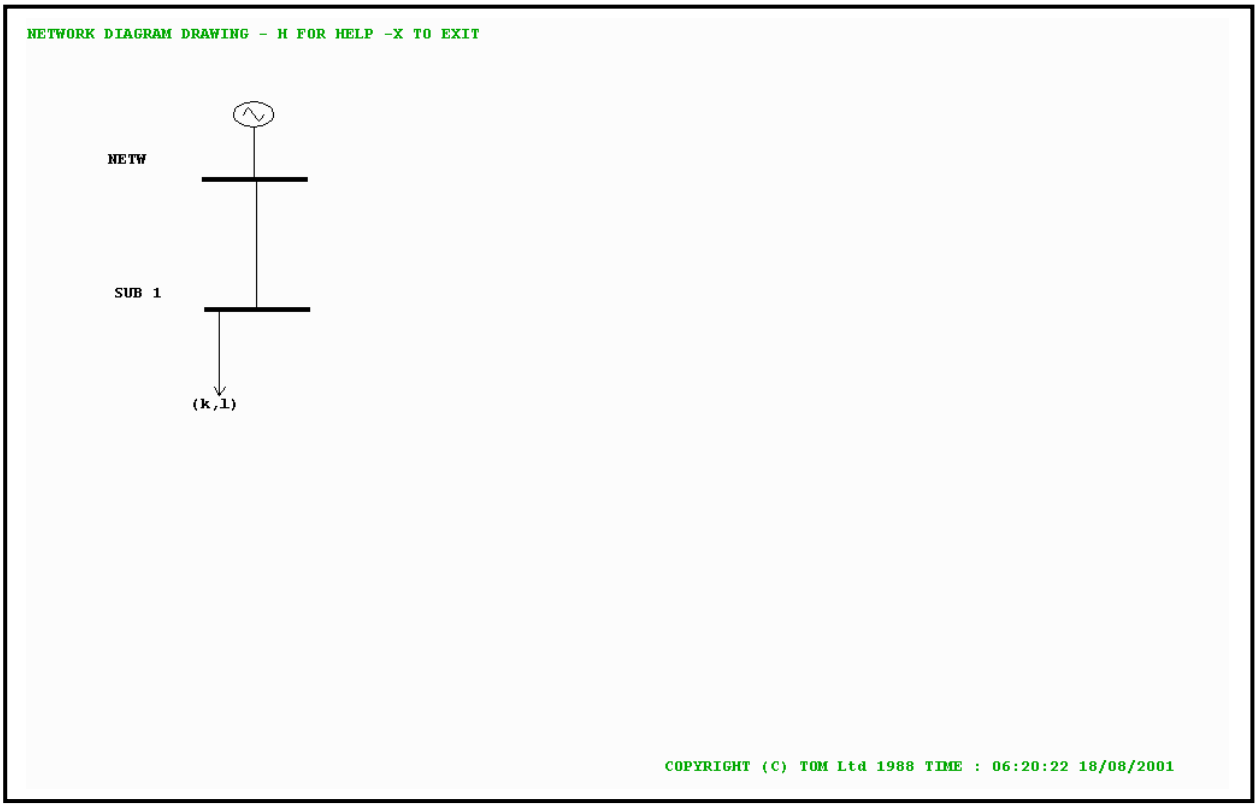


Figure 3-33

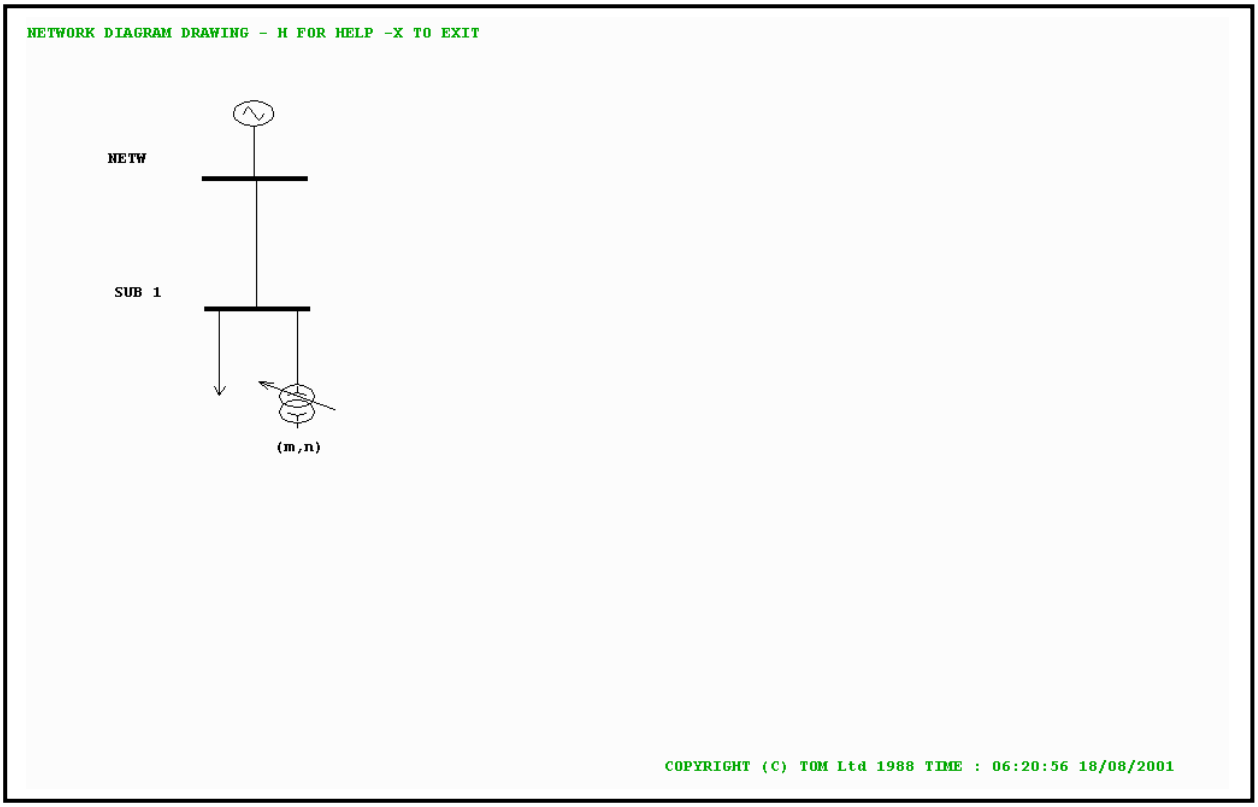


Figure 3-34

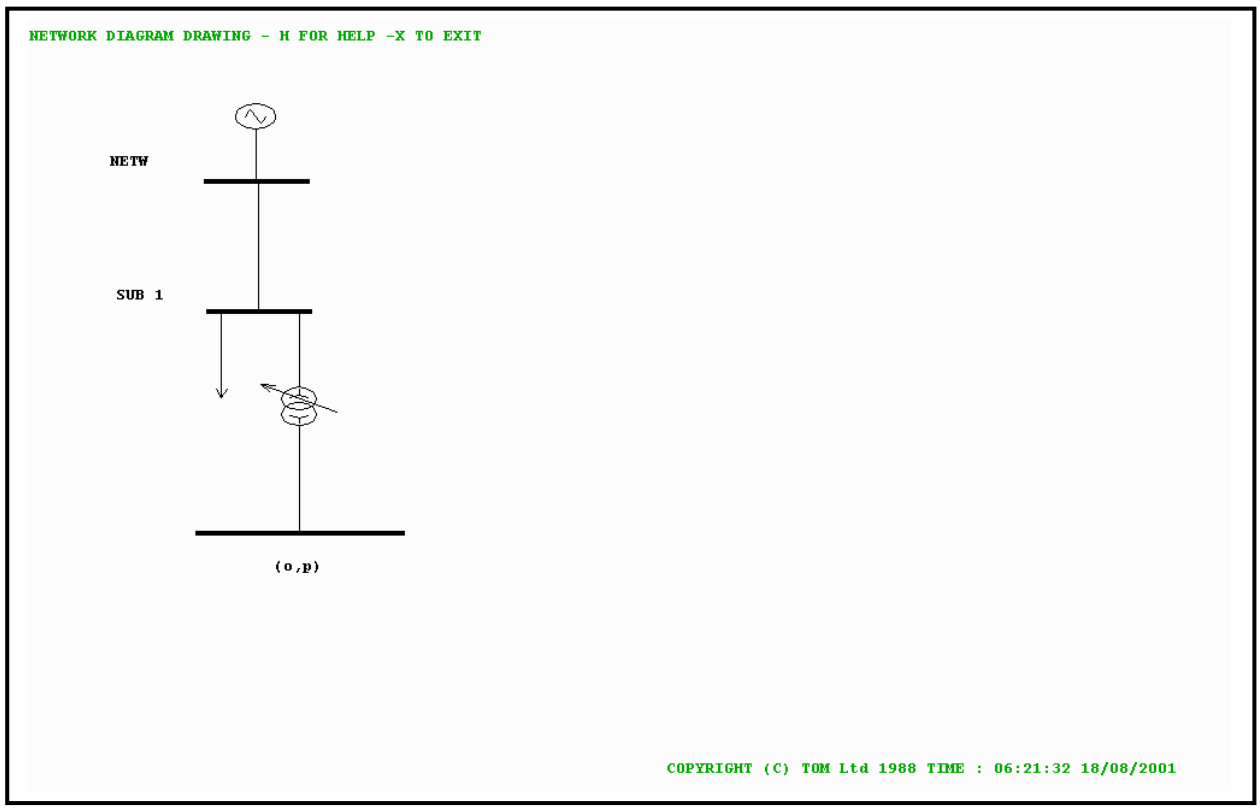


Figure 3-35

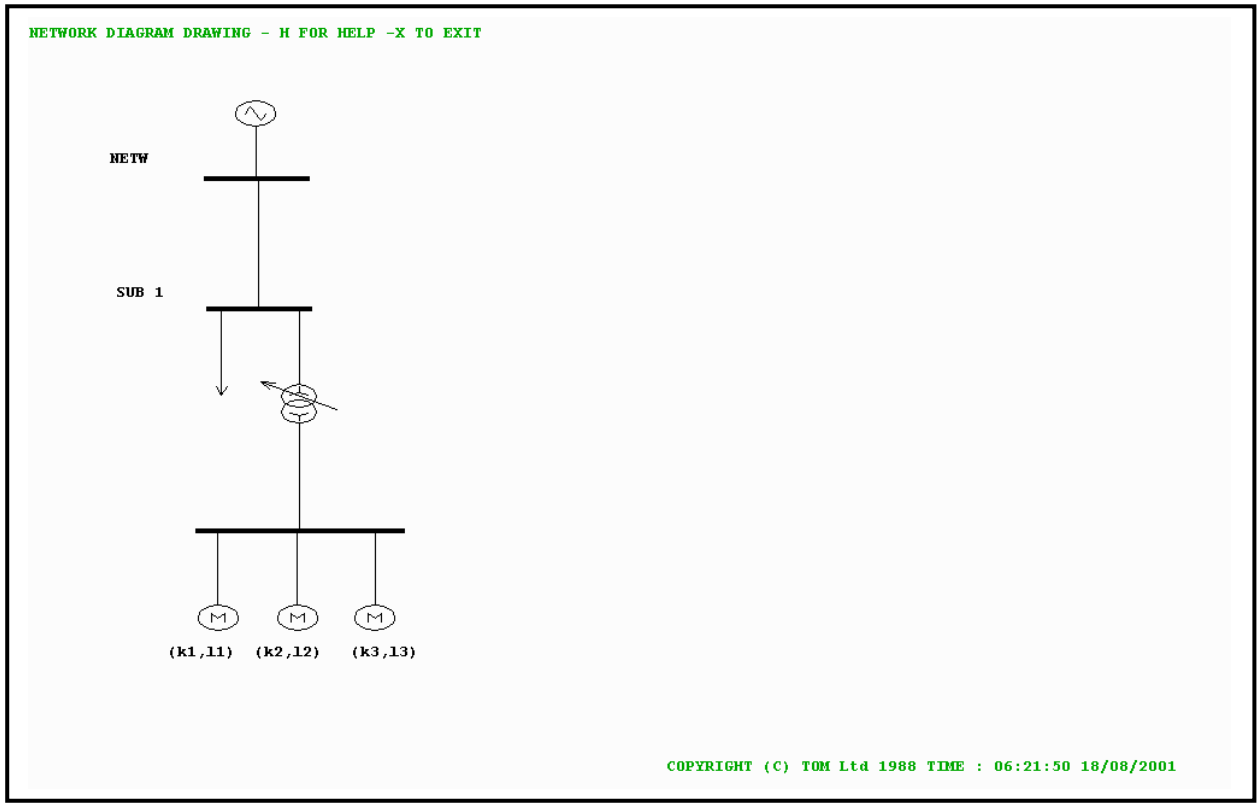


Figure 3-36

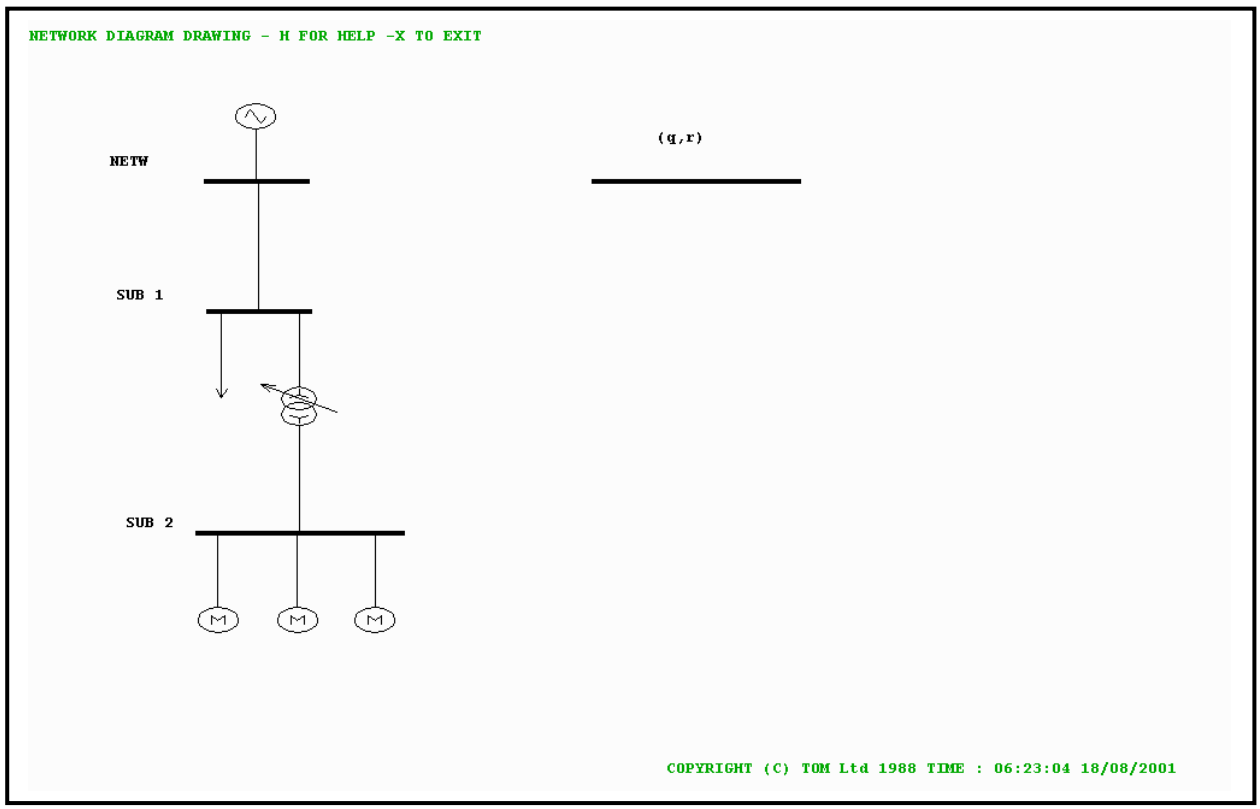


Figure 3-37

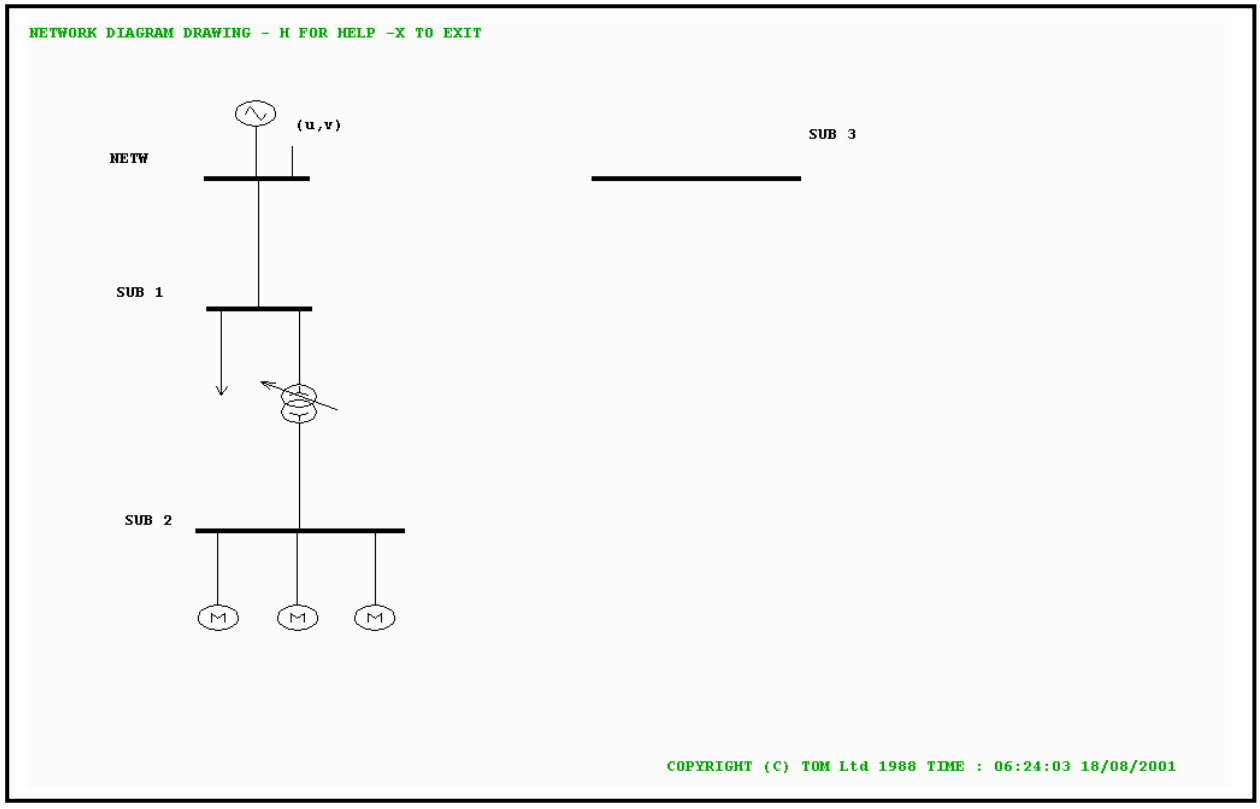


Figure 3-38

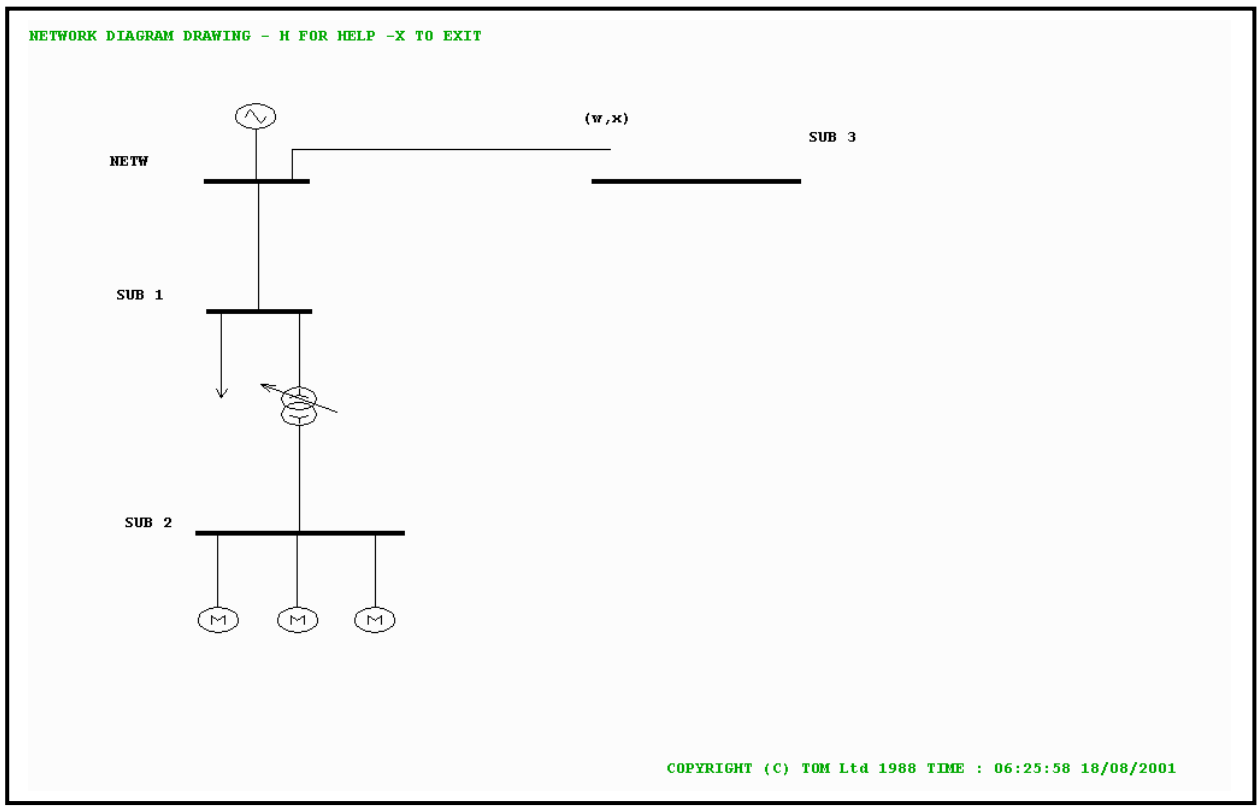


Figure 3-39

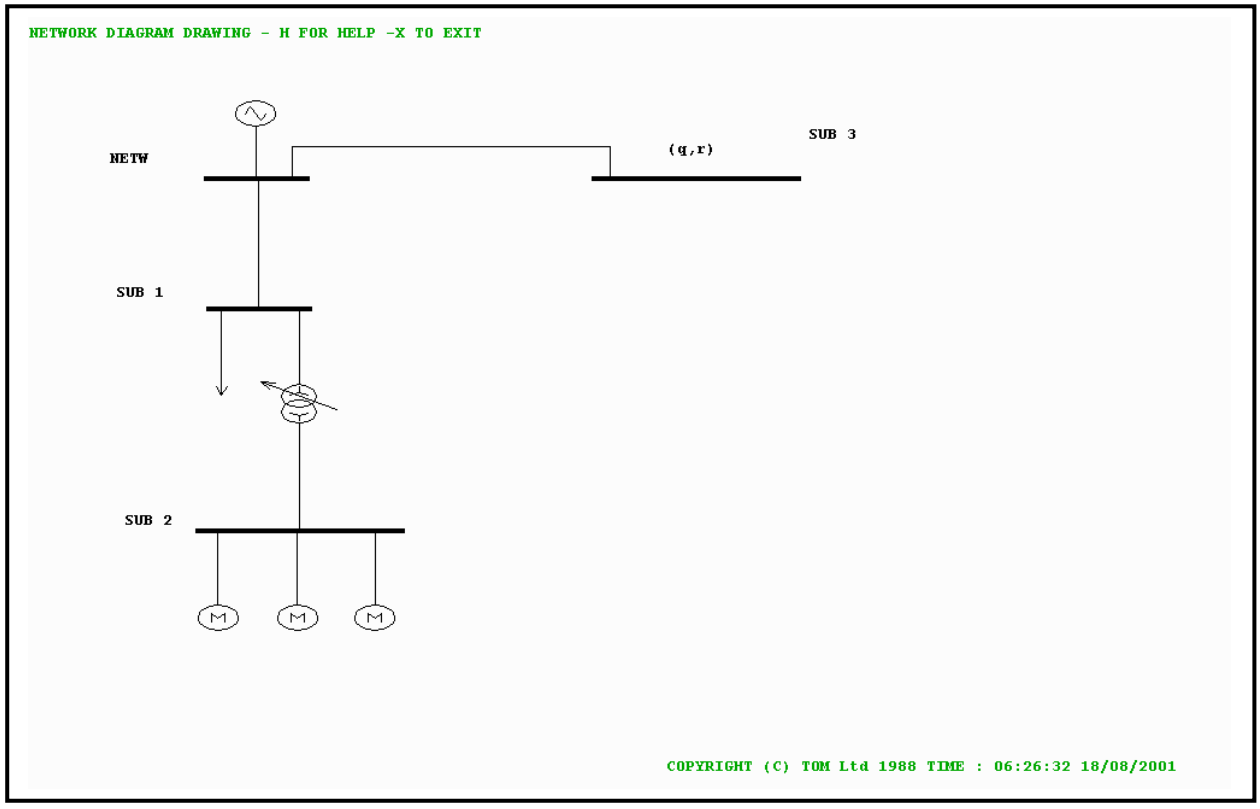


Figure 3-40

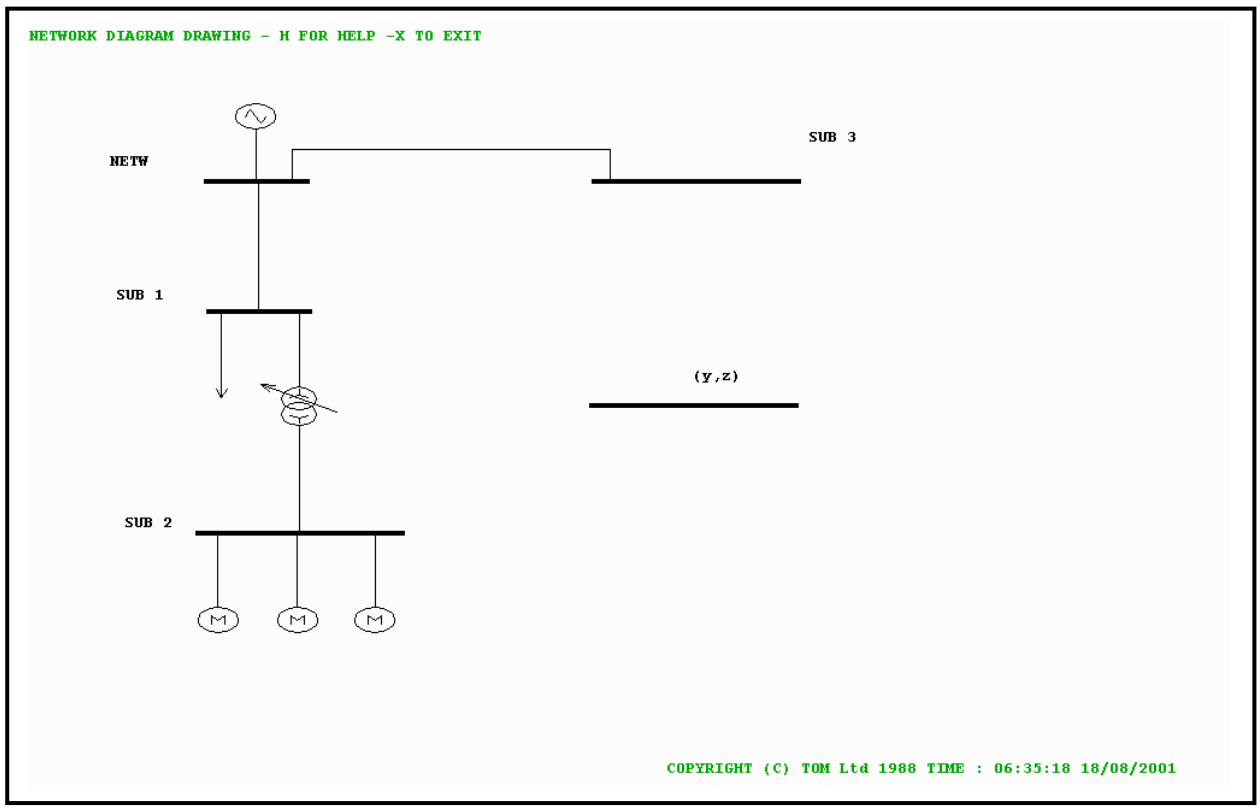


Figure 3-41

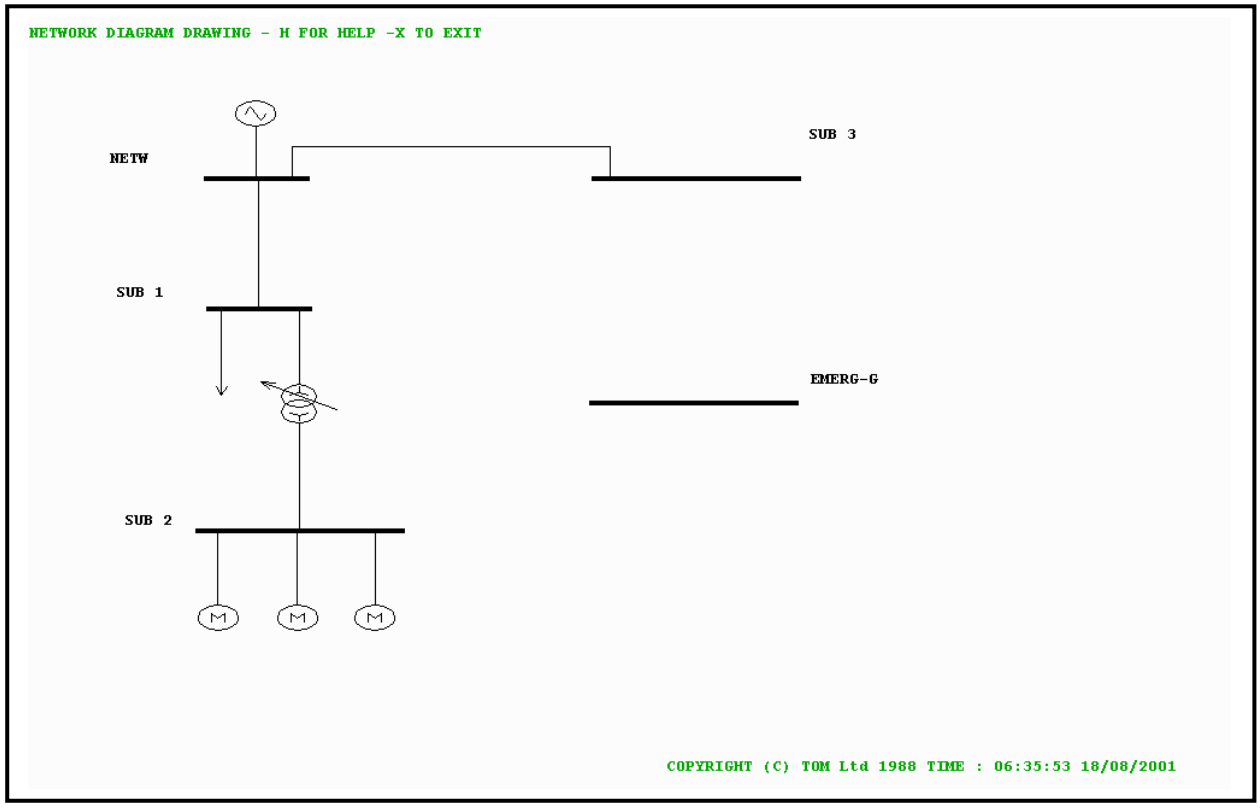


Figure 3-42

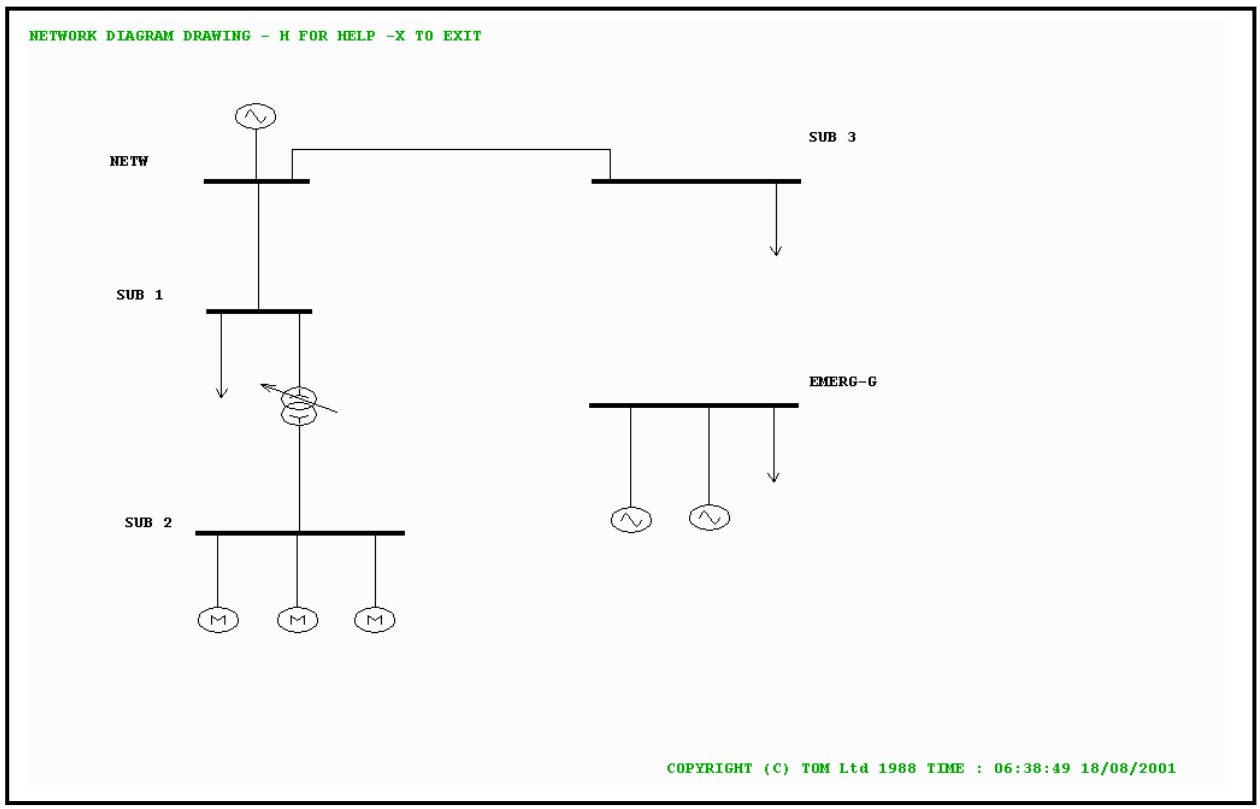


Figure 3-43

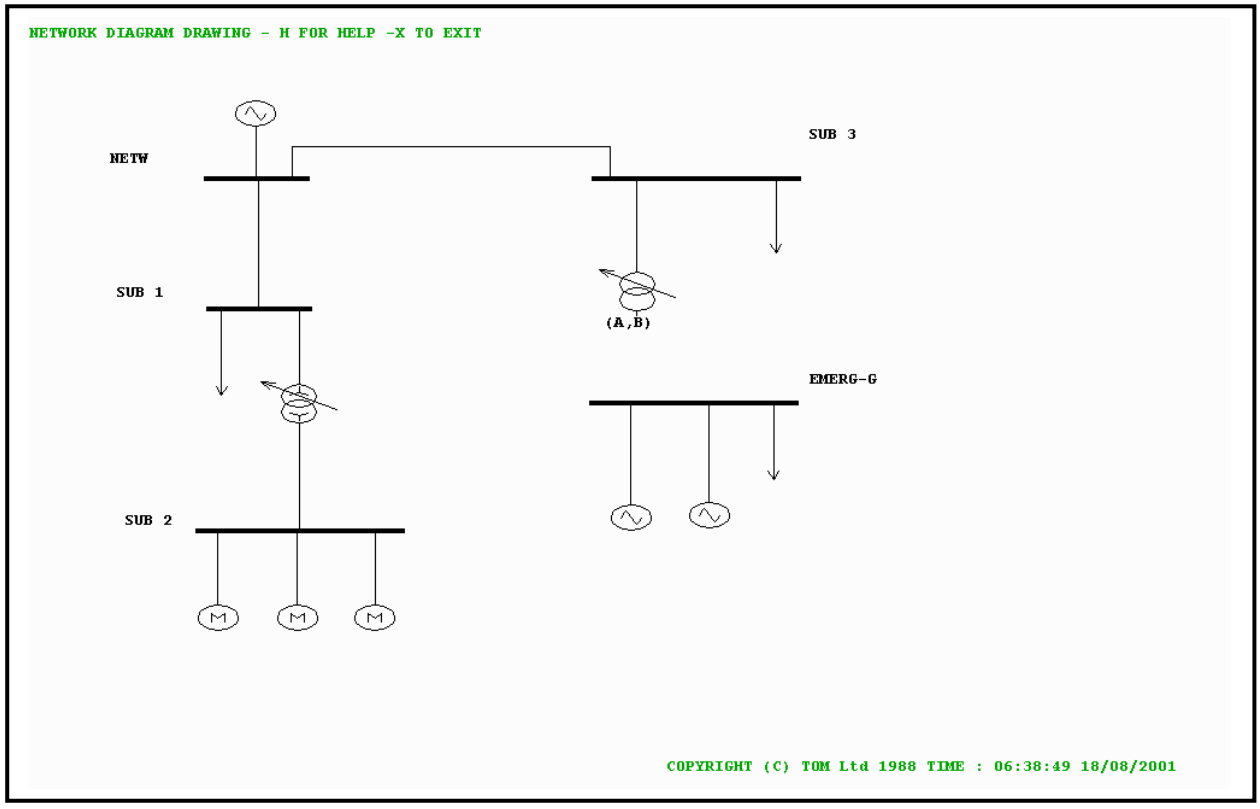


Figure 3-44

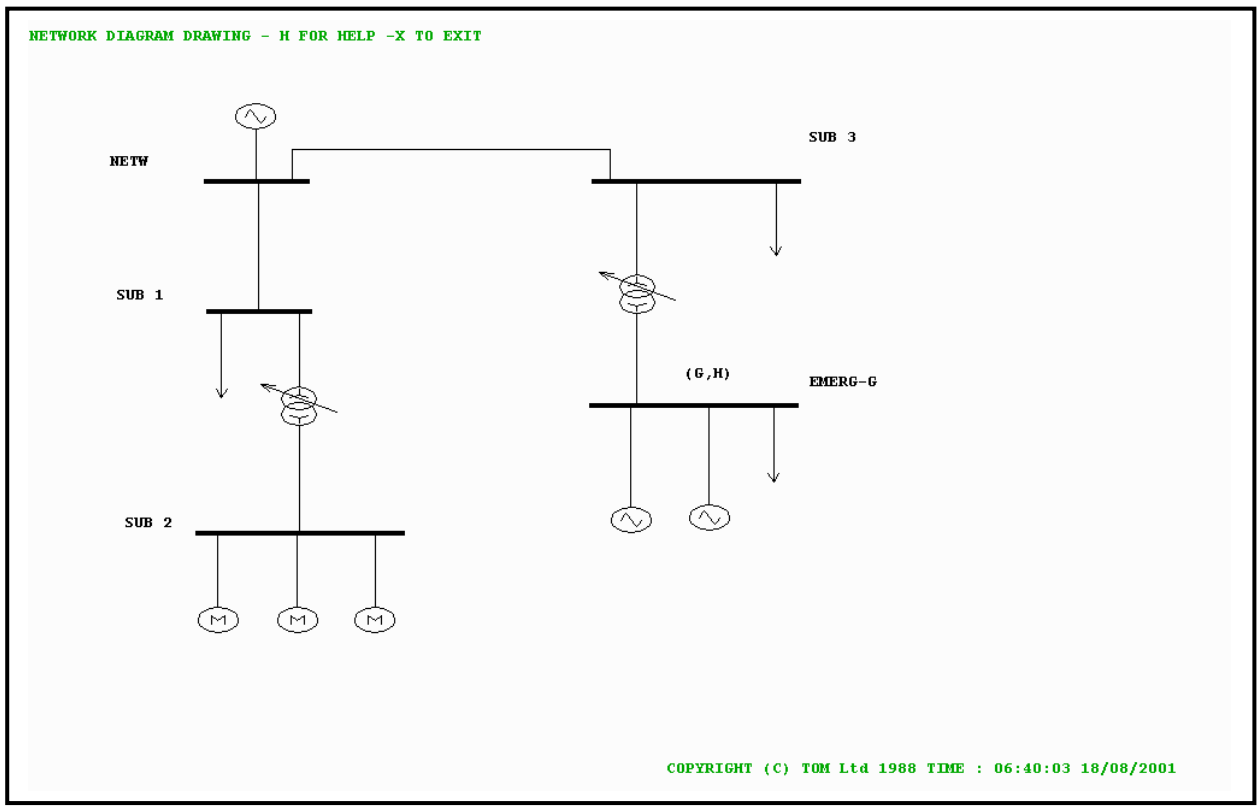


Figure 3-45

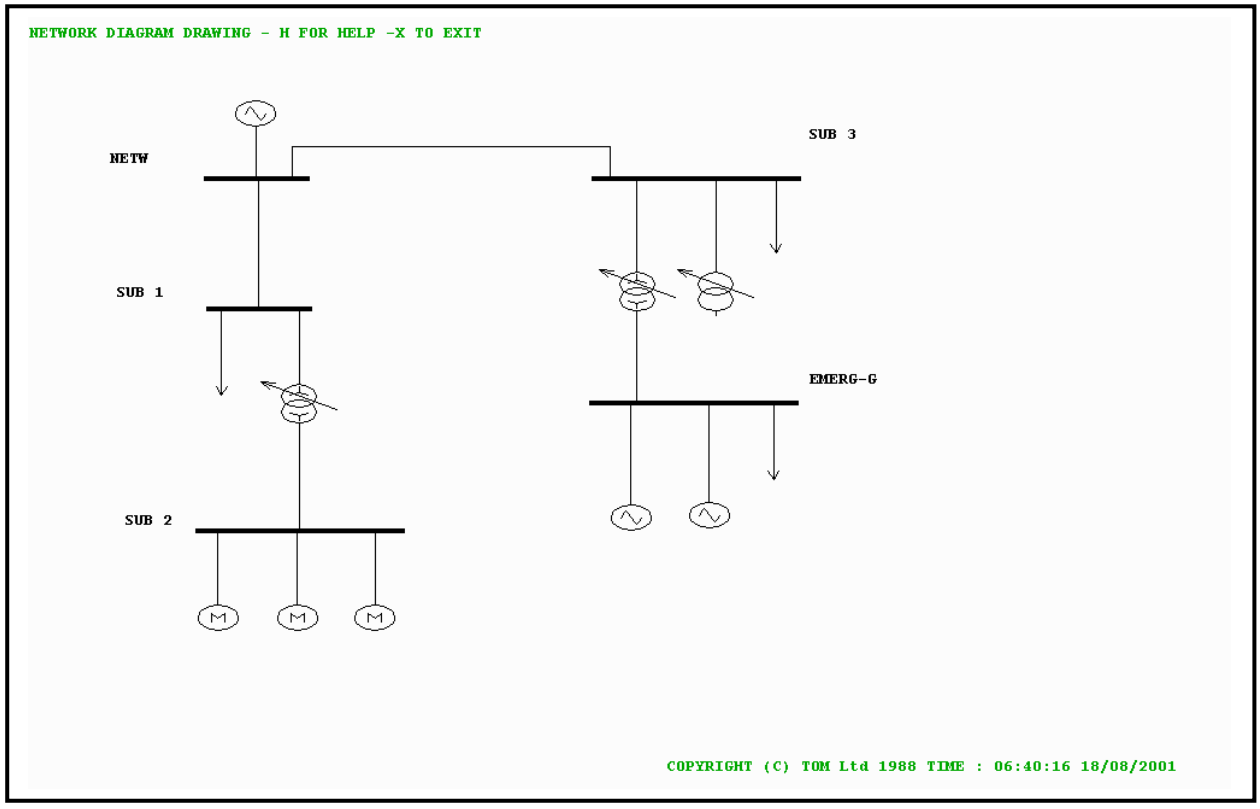


Figure 3-46

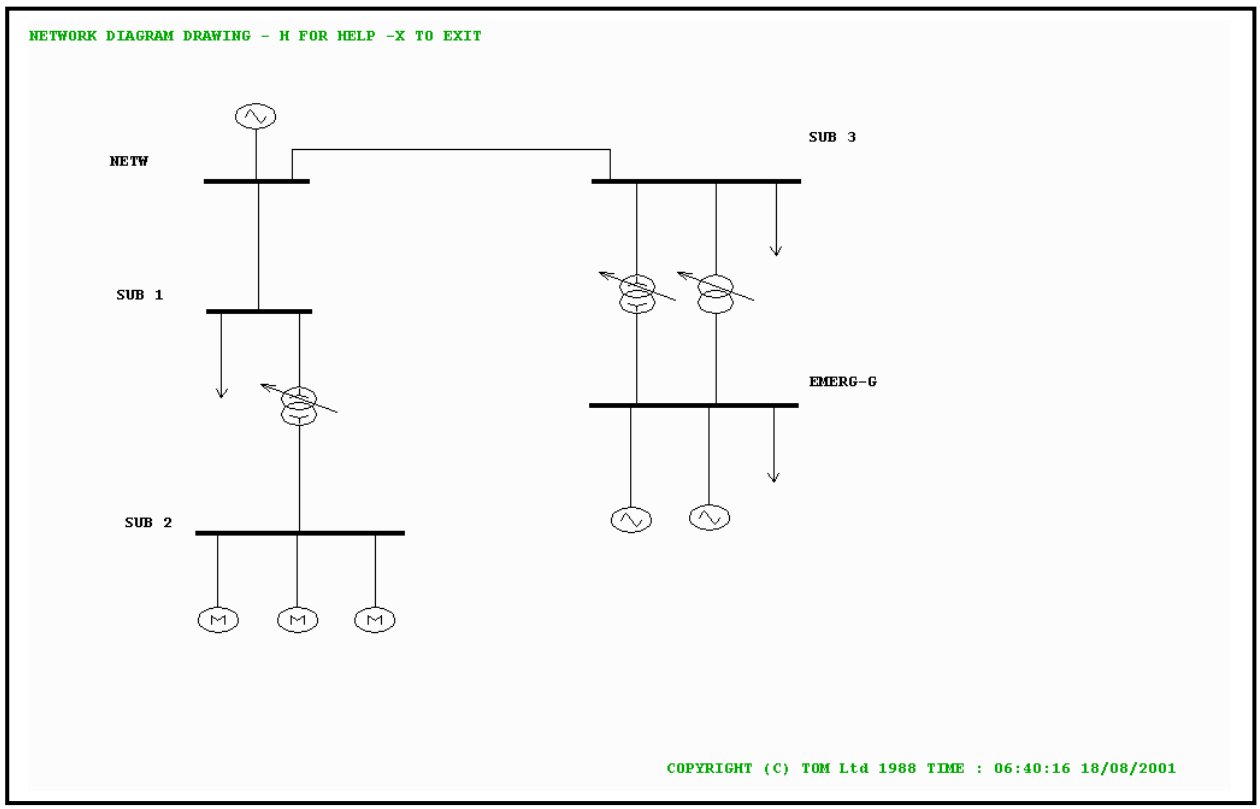


Figure 3-47

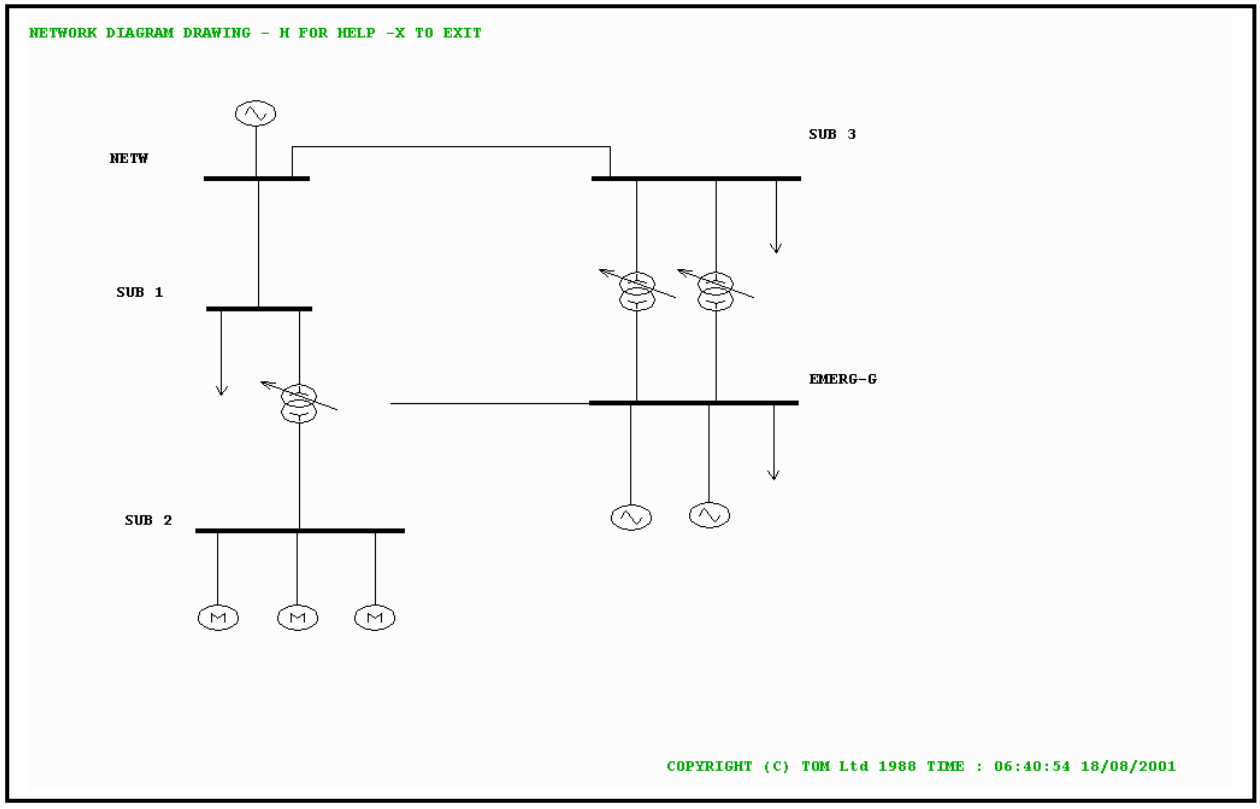


Figure 3-48

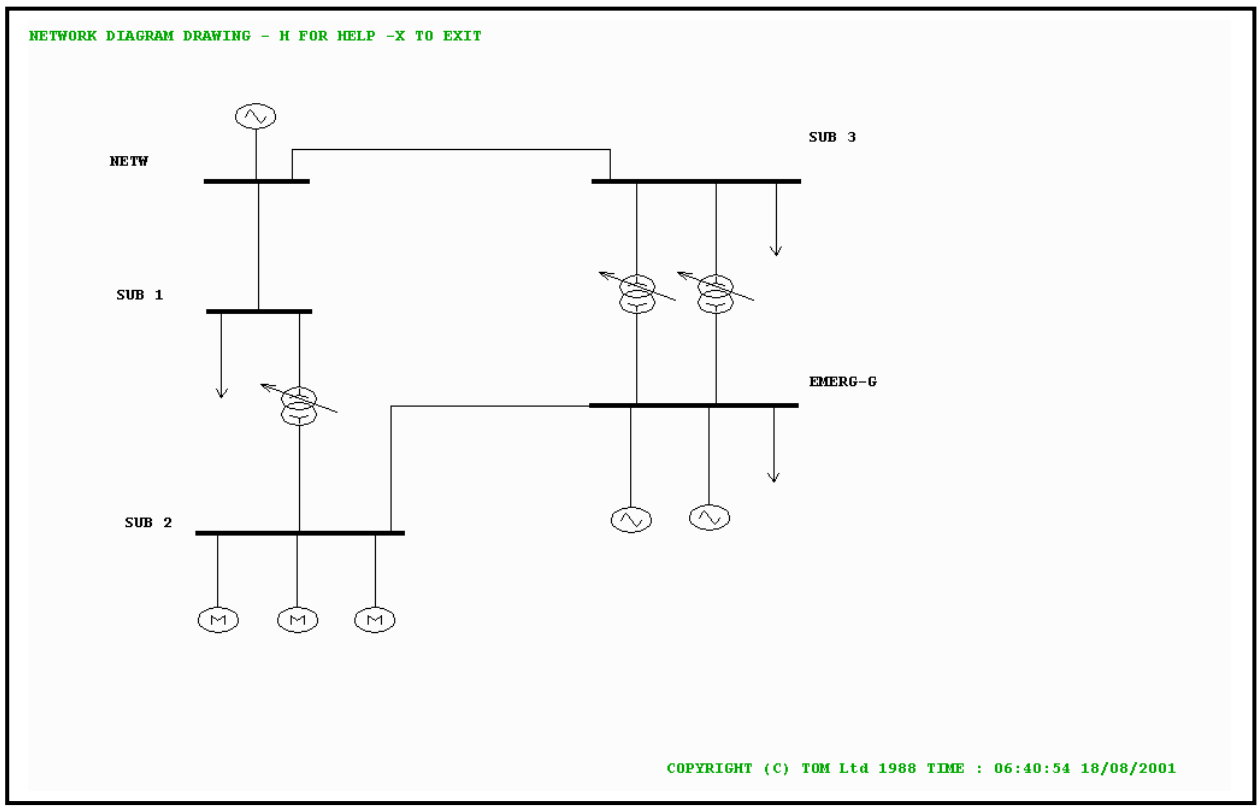


Figure 3-49

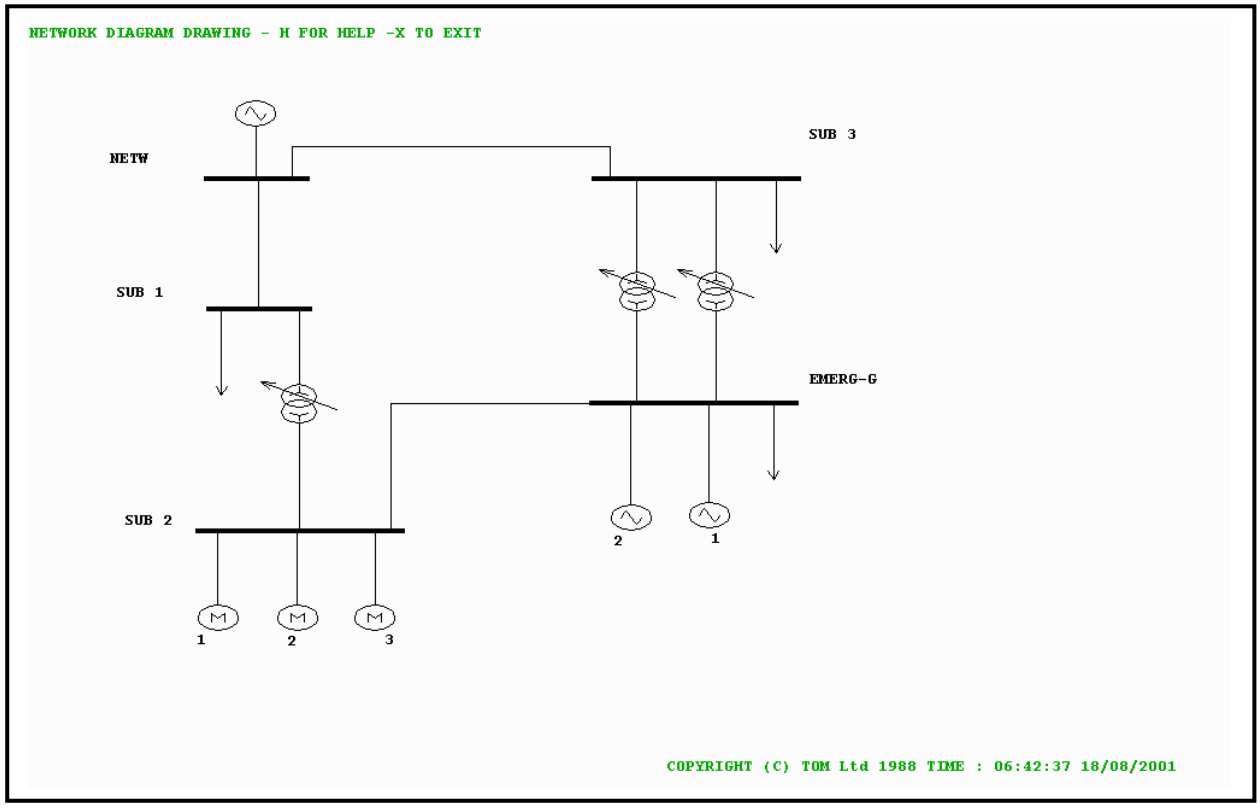


Figure 3-50

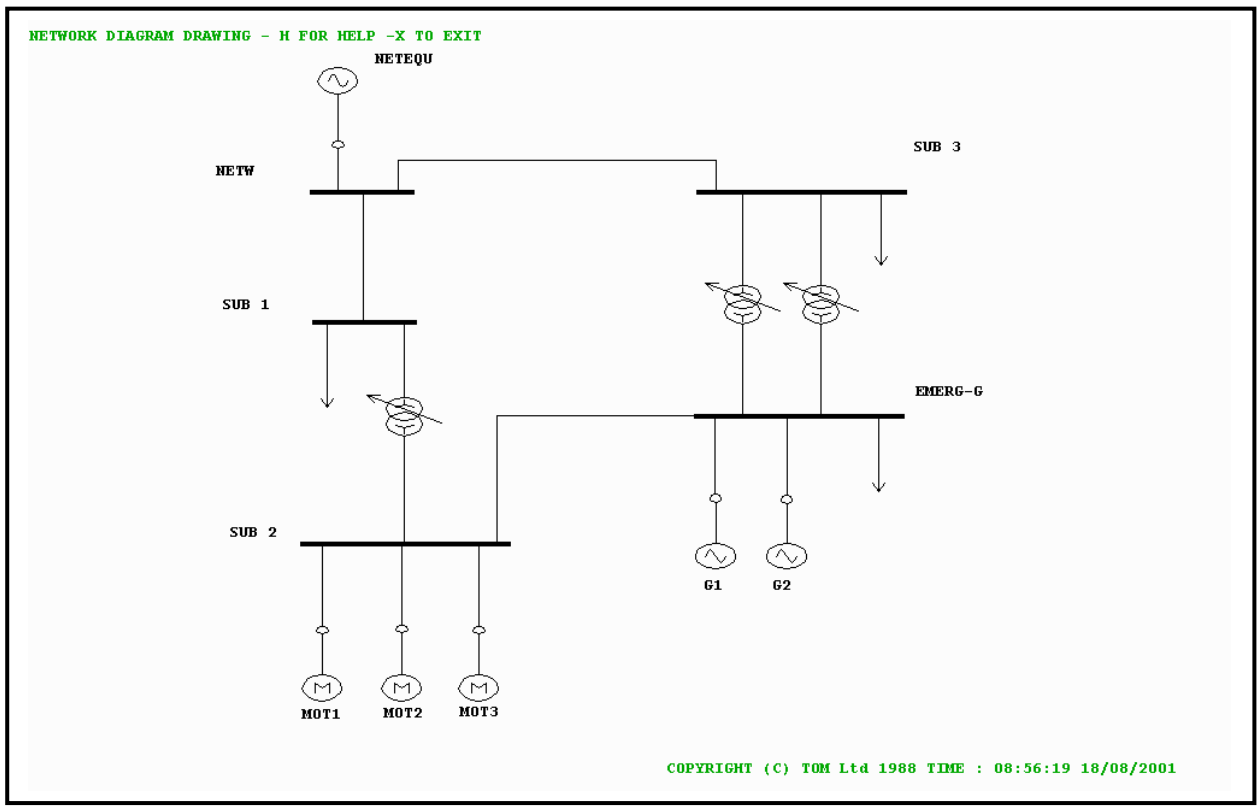

NETWORK DIAGRAM DRAWING - H FOR HELP -X TO EXIT
NETEQU
NETW
SUB 3
SUB 1
EMERG-G
SUB 2
G1
G2
MOT1
MOT2
MOT3
COPYRIGHT (C) TOM Ltd 1988 TIME : 08:56:19 18/08/2001

Figure 3-51

Figure 3.40: The circuit is then drawn to the substation at (q,r) by positioning the cursor over it and typing <C>.

Figure 3.41: A new substation is drawn at (y,z) by pressing the <3> key.

Figure 3.42: The new substation is named 'EMERG-G'.

Figure 3.43: Two generators and a load symbol have attached to the new substation, similar to above. A load (pressing <L>) is also connected to SUB 3.

Figure 3.44: The cursor is then positioned over SUB 3 and a <3> pressed to select it as the current substation. The cursor is then moved to (A,B) and a <T> typed to draw an in line transformer segment.

Figure 3.45: The cursor is moved to (G,H) and a <C> typed to terminate the circuit at EMERG_G.

Figures 3.46 and 3.47: A similar transformer circuit has been drawn from SUB 3 to EMERG-G in exactly the way described above.

Figure 3.48: A circuit is initiated from EMERG-G.

Figure 3.49: The completed diagram is shown here. To complete it the cursor is positioned over SUB 2 and <C> is pressed.

Figure 3.50: The figure shows the ID's of the generators and motors. These are obtained after entering ID in the editing DATA (Chapter 4). Press <F1> (see 3.4) over a machine symbol in order to go to the edit page.

You may draw the example just described in the same manner as written in section 3.1 just by clicking mouse using the tool bars. This is left for user as an exercise.

3.3.1 Other considerations

It is a good practice to connect the generators or motors to junctions instead of directly connect them to substations. There are many advantages of doing this as described in the followings:

1) Generators usually connect to the main substations by transformers or through bus ducts.
2) Motor terminals are connected to MCC substations by cables.
3) PASHA protection relays can be located in the lines as described in chapter 11.
4) There is no need to place an ID for the machine, as the name of junction will do the job.

Figure 3.51 shows the previous diagram drawn by using junction for the machine terminals.

The user can try to construct this diagram from scratch or use the modification keys as described in section 3.5 to covert the present example shown in figure 3.49 to that shown in figure 3.51.

3.4 Miscellaneous display keys

There are a number of keys defined that provide general screen functions. These may also be selected from the green tool bars. These are described below.

The <E> key

Erases the screen and redraws the diagram. It is useful after a diagram modification command has been performed to clear the screen of the old diagram and re-draw it as it now is.

The <F1>, <F2>,<F3>,<F4>,<F5>,<F6> keys

You can directly go to the data tables in edit section by pressing these keys when the mouse cursor is located on an element. For example pressing key <F1> while the cursor is over a busbar brings BUSBAR DATA PAGE1 (Chapter 4) and the data of the selected element will show in red. Please also see section 2.2.4.

The <H> key

Displays four pages of on-line 'help' information that explains concisely the functioning of all the keys in the drawing section.

The <O> key

This key calls up options to permit scaling and re-centring of the diagram. However, it may be considered as obsolete routine with introducing the <Z> key for zoom, which zooms in an area. Scroll bars also working in windows. Beside, zoom in a selectable area may also be used. All of these keys are described in chapter 2, when expressing the options available with mouse right click. However, for the sake of compatibility with previous versions and also for using in special situations like when the single-line diagram constructed, contains no area, it is described here.

Figure 3.52 shows these options along with the example from the last section (3.4). The options are as follows:

[CHANGE SIZE]: Allows the user to rescale the diagram by entering a scaling factor. Scale factors less than one will shrink the diagram and those greater than one will increase the size of the diagram. The scaling factor changes the size of the network symbols etc. but the size of busbar names remains the same. Consequently when the diagram is reduced substantially it becomes difficult to locate the busbar names properly. Names are, therefore, not displayed when the scaling factor is less than 0.7. The scaling may take place in X or Y direction if this option is selected by pressing key <X> or <Y> respectively. However in this case the shape of the element symbols will also be changed respectively.

Figure 3.53 shows the option box with the cursor over this option. The option is selected by a click. The program then prompts for a scaling factor, as shown in figure 3.54. Figure 3.55

shows a diagram that has been scaled by entering '0.5' in response to the prompt. The diagram is half its original size.

[CHANGE SIZE AND RECENTRE] : Enables the user to rescale the network diagram as well as to choose a new centre point for the display. The current center is marked with an 'X' when this option is selected. In windows and Linux platforms you may use scroll bars whenever a single-line diagram is on the screen.

[CONTINUE DRAWING] : Exits from the scaling options and allows the user to continue drawing.

[RECENTRE] : Enables the user to re-centre the diagram, thereby allowing a diagram larger than the physical screen size to be constructed. When this option is selected an 'X' is displayed in the centre of the diagram and the user is invited to specify a new centre point by moving the cross hair cursor to his new centre point and pressing the <SP> key or a click. However, if an 'N' is typed at this point and an existing busbar name is entered, this busbar is drawn at the centre of the screen.

Figure 3.56 shows the diagram from section 3.4 after the [RECENTRE] option has been selected. An 'X' is shown at the center of the diagram. The cursor is positioned as shown and a click is pressed. This selects the new center point. The diagram is then redrawn as shown in figure 3.57. It has been shifted so that the new center point is situated at the center of the screen.

[RESET TO NORMAL SIZE] : Resets the diagram to the default size before any scaling changes were made.

The <X> key

This key exits from the drawing section of PASHA and returns control to the main options menu.

The <Z> key

This key is used to zoom on a window, see section 3.7 for more information about window. Locate the cursor anywhere inside a window and press Z to zoom on that window.

The <Alt / ShiftZ> key

This key is used to zoom on a selectable area. Pressing this key invites the user to drag an area on the screen. Computer zooms on the area that is dragged. The key Shift+Z will do the task in Windows environment while in other platforms Alt+Z will do the job.

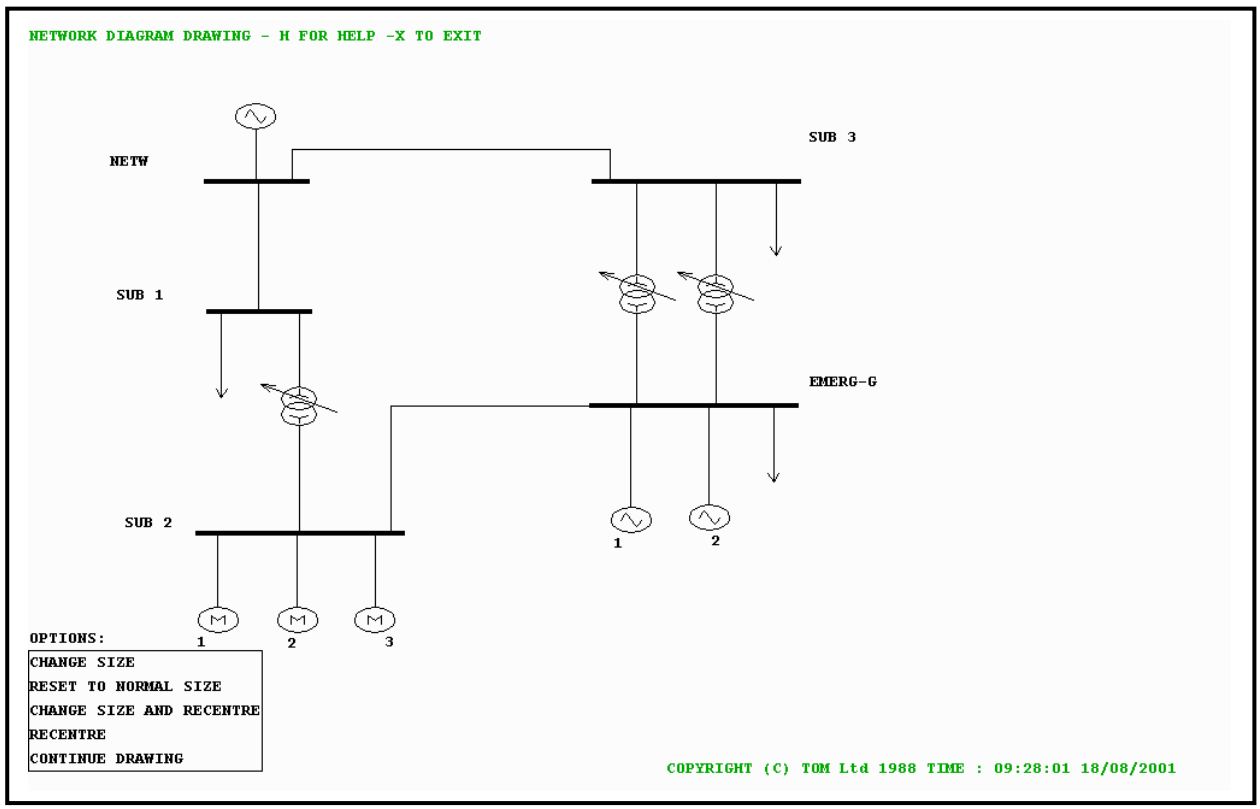


Figure 3-52

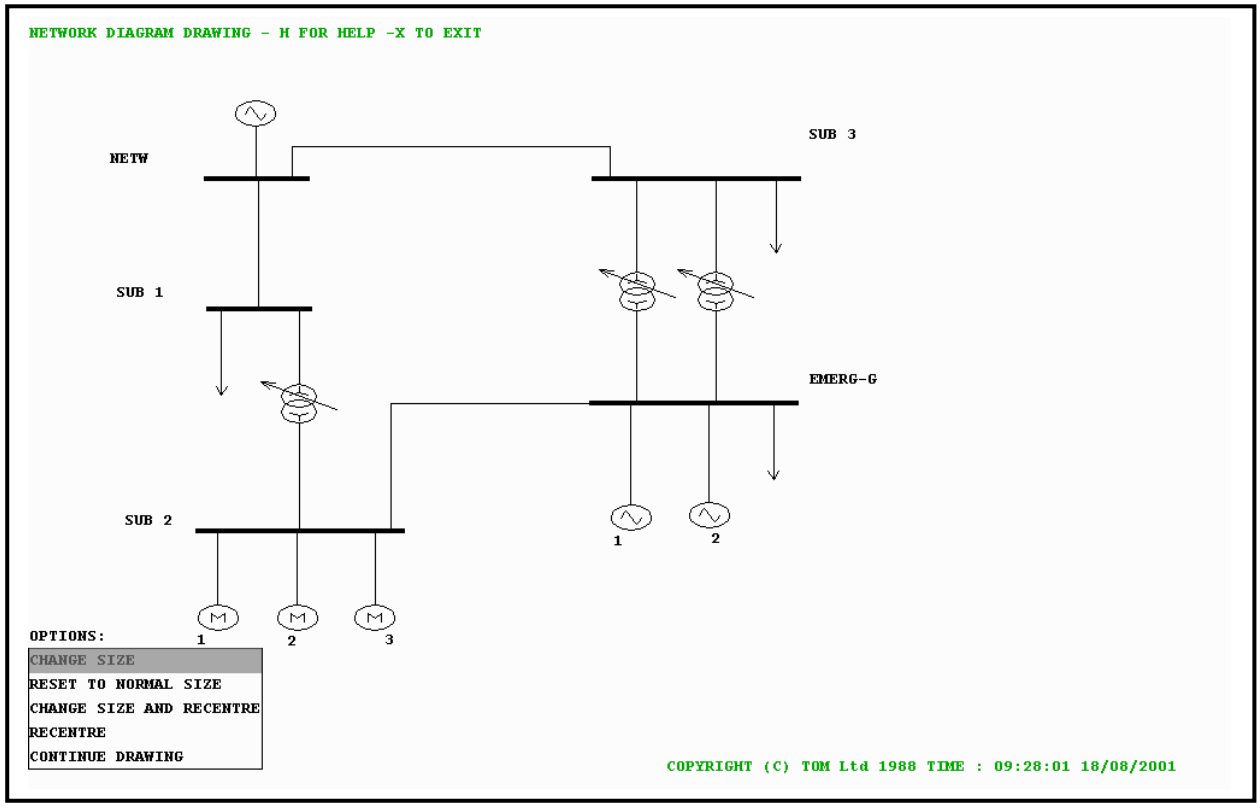


Figure 3-53

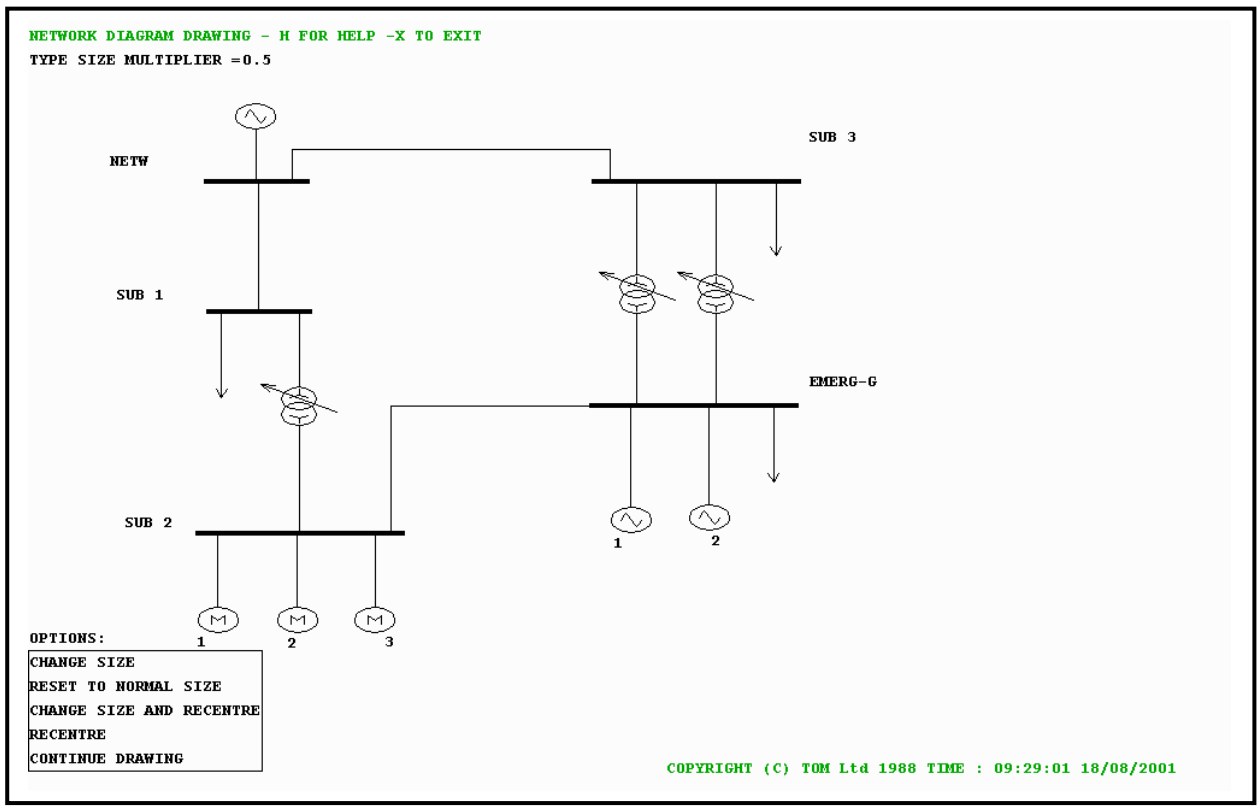


Figure 3-54

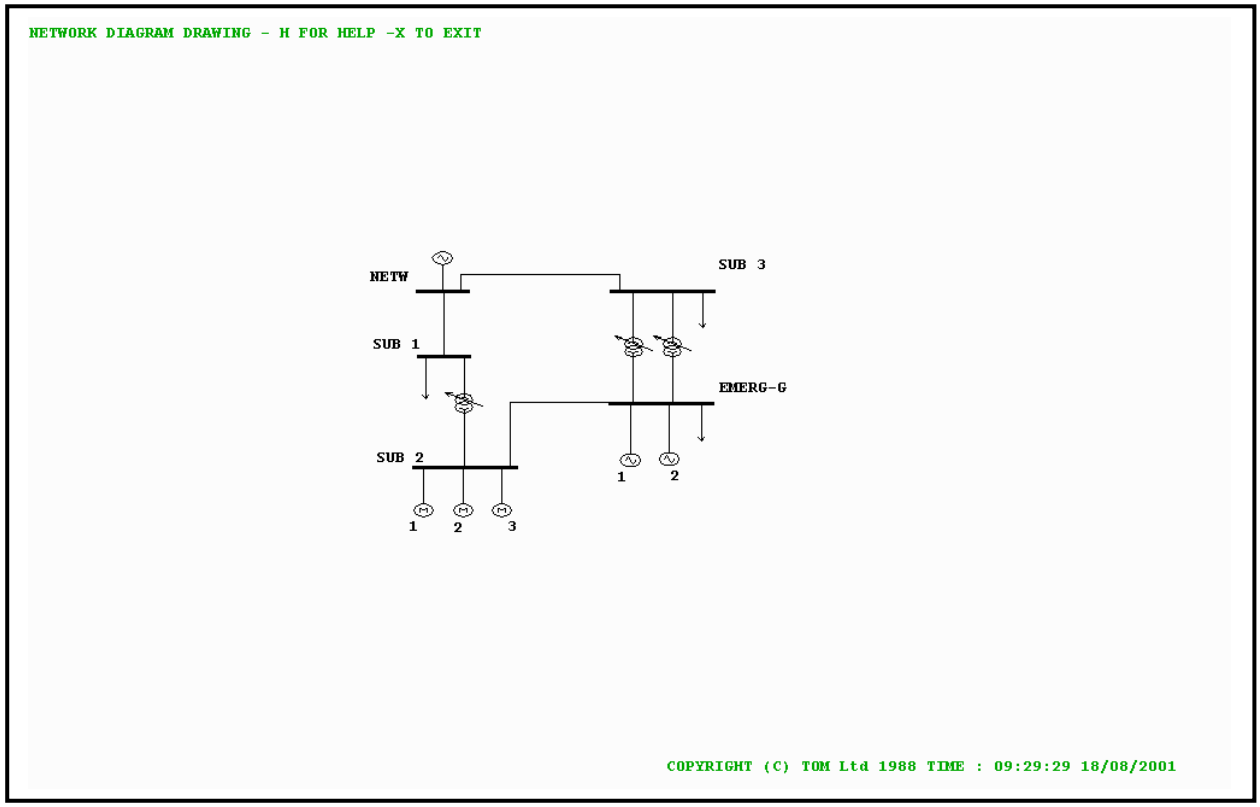


Figure 3-55

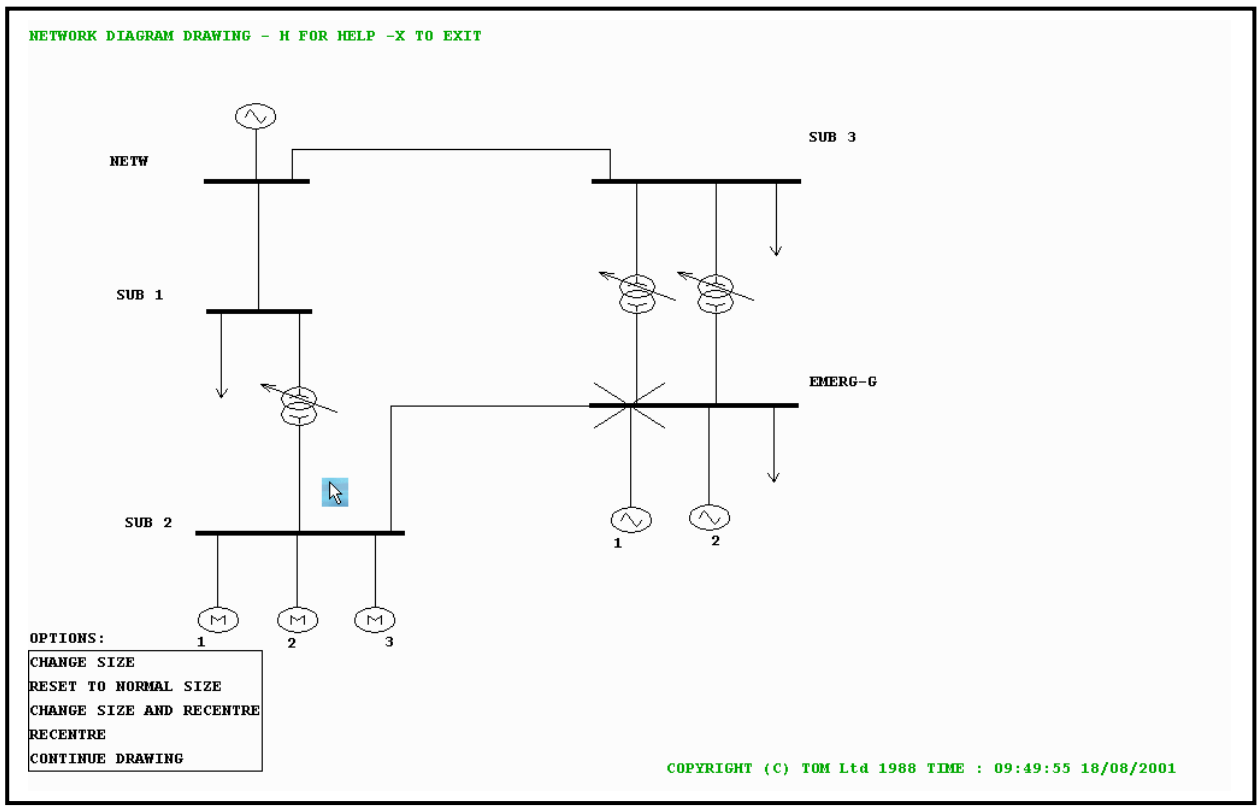


Figure 3-56

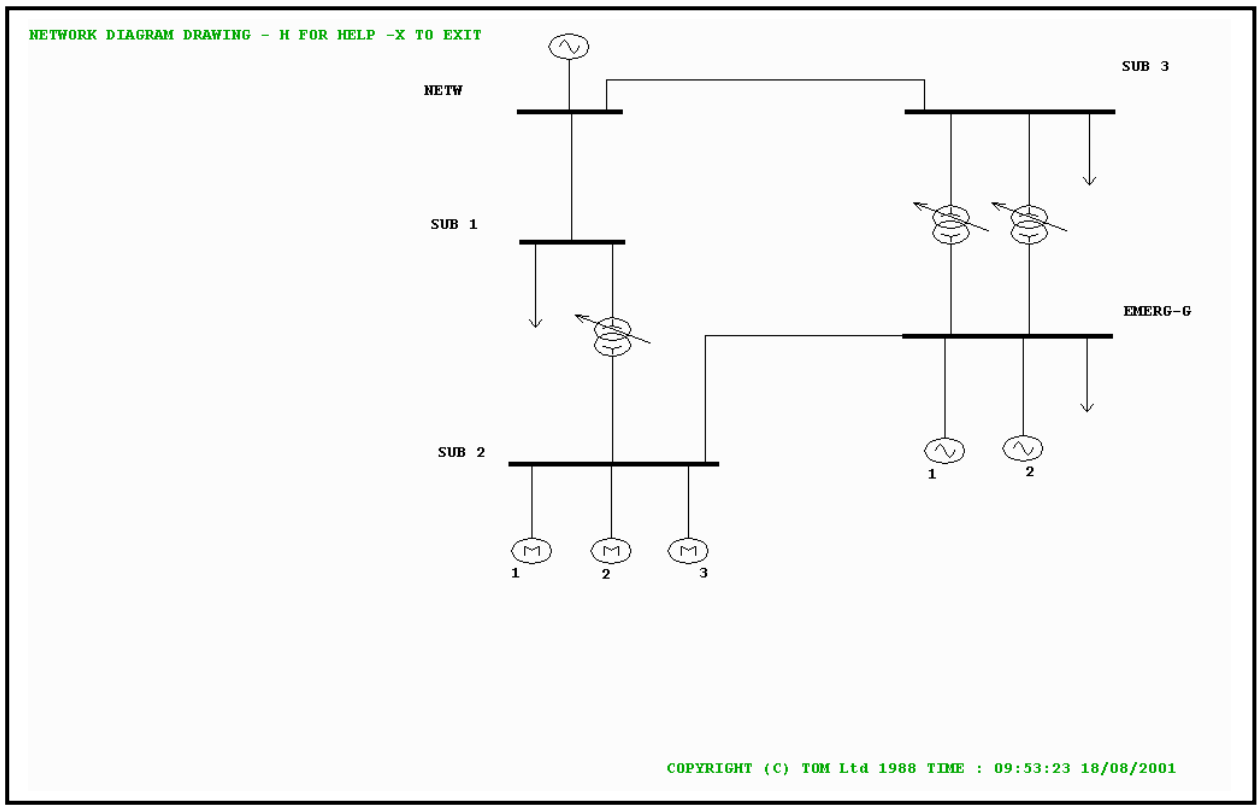


Figure 3-57

3.5 Drawing modification commands

No drawing utility would be complete without some means of changing the diagram structure because of error or a modification to the original design. In PASHA this function is performed by the <F>, <D> and <M> keys, which allow deletion and movement of diagram elements. These keys may also be selected from tool bars. When you select a Delete or Move from tool bars, the computer will go to delete or move mode respectively.

The <F> key

The <F> key can be used to 'forget' the last drawing command used, i.e. if a connection has been made it will delete the connection, if a generator has been drawn it will delete the generator. The forget command can be used as many times as required and will delete each item drawn on the diagram in reverse order until the screen is empty.

Figure 3.58 shows what happens when the <F> key is pressed after the completed diagram in section 3.4 has been drawn. The last element drawn on the diagram was the last connection segment between EMERG-G and SUB 2. This is therefore deleted as shown in the diagram by the crossing out lines. Figure 3.59 shows the diagram after the <E> key has been pressed to redraw the diagram, the connection segment is now missing. Selecting the Forget from toll bars will do the same job as pressing <F>.

3.5.1 Delete mode

The <D> key is used to start 'delete mode', which enables the user to delete any of the diagram elements that he has previously drawn. To enter delete mode, it is first necessary to press a <D> or select this option from tool bars. This key initiates delete mode for the deletion of any number of network items. Then you must position the cursor over the required element at which the deletion process is to commence, and type <D> or just do a click, or press the key symbol of the commence element for example <G> for generator. The selected element will be deleted. All the symbols including lines, can be deleted in this way, except load symbols which you must position the cursor over the connected substation and press <L>.

For three windings transformers each leg must be deleted separately and then the central junction must be deleted too. For infeeding transformers the position of the cursor must be carefully selected on the W end. For shunt elements the cursor must also be positioned over the end of the shunt symbol near the earthing point.

Note that the substation, busbar and junction deletion is permitted only after all the connected items have already been deleted.

Any data present for a deleted element will be automatically removed from the data 'slots' (see 4.1).

The zooming keys are also works in the deletion mode and zooms in the user required area.

To terminate delete mode it is necessary to type a <space-bar> or to select another option from the tool bar For new users the most satisfactory way to exit from the 'delete' routine if

he does not want to use the tool bars is to press the <SP>. This produces the message: 'Code not recognized please try again' and gives a clear indication that the normal drawing procedure has been re-entered.

If you would like to delete an entire area please see section 3.7 to find out how you may delete a window including all the components inside that window. It is also possible to put the equivalent of a part of a network when deleting that part.

3.5.1.1 Examples of deletion commands

To illustrate the use of the deletion keys, examples are shown in figures 3.60-3.66.

Figures 3.56 and 3.57 show a circuit being deleted. In 3.60 the cursor is positioned over SUB 2 and the <D> key pressed. The cursor is then moved over EMERG-G (the end point of the circuit) and the <C> key is pressed. The line is then deleted as shown in figure 3.61. Note: the whole of the circuit is deleted, not just a single segment as with the <F> key.

If the tool bar is available, you may simply locate the cursor over the line and click for deletion of the line.

Figure 3.62 and 3.63 show the deletion of a generator. The cursor is positioned over NETW as shown in figure 3.62 and the <D> key is pressed. The cursor is then moved over the generator, as shown in figure 3.63, and the <G> key is pressed. The generator is then deleted as shown. This may be done simpler by selecting the Del for tool bars and just locate the cursor over the generator symbol and click mouse.

Figures 3.64 - 3.66 show a substation being deleted. Before a substation can be deleted, it is necessary to delete all the plant attached to it. Figure 3.64 shows this; the connections from NETW to SUB 1 and SUB 3 are shown deleted. The generator has also been deleted. The cursor is positioned over NETW and the <D> key is pressed. An <S> is then pressed and the substation is deleted as shown in figure 3.65.

The deletion may be done by using tool bars. In this case, just select the Del from tool bars and then click on all the connected plants and then the substation itself. After an erase and re-draw command has been executed the diagram will now appear as in figure 3.66.

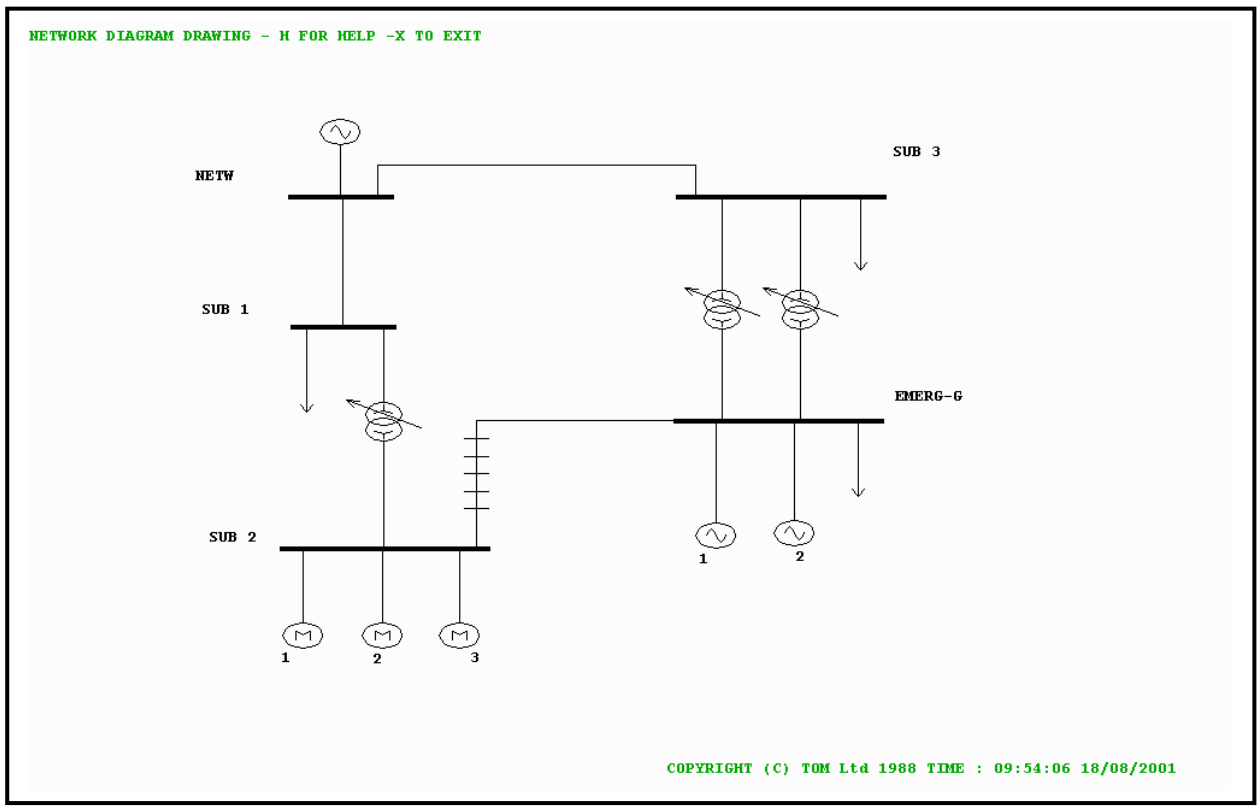


Figure 3-58

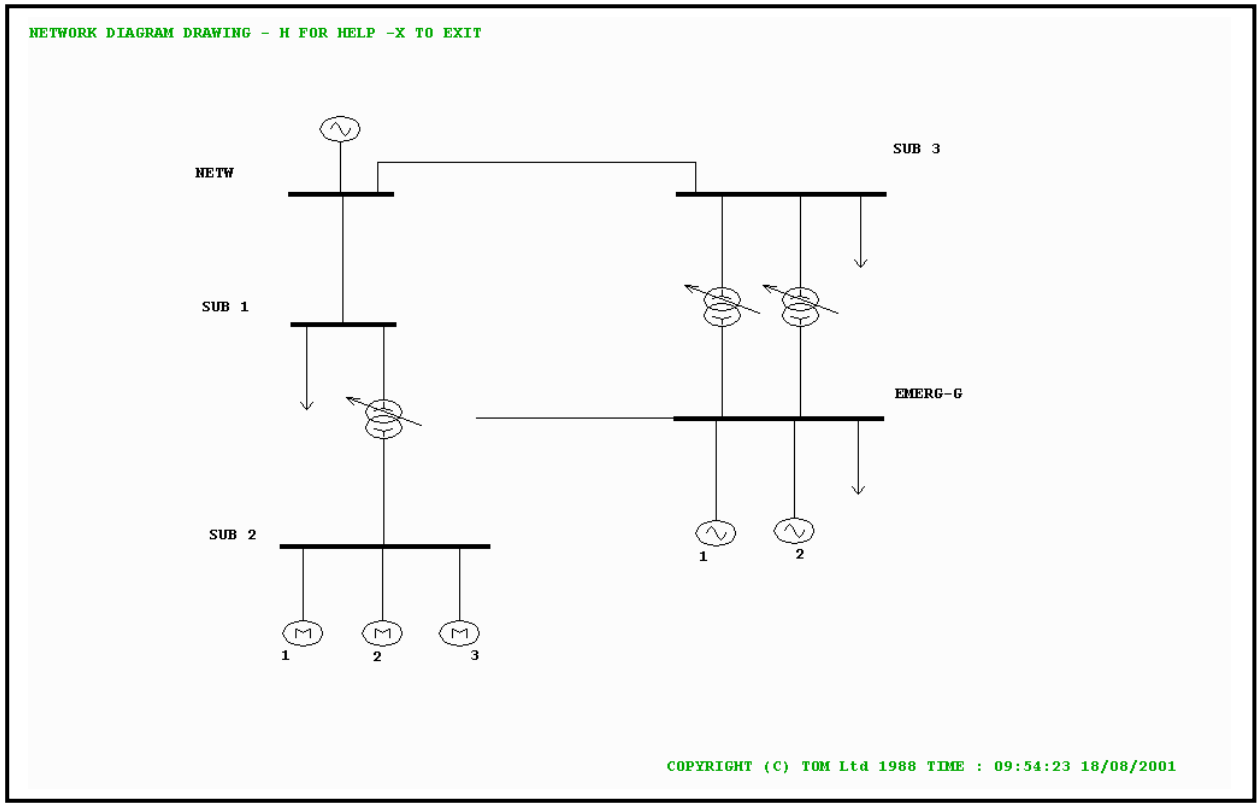


Figure 3-59

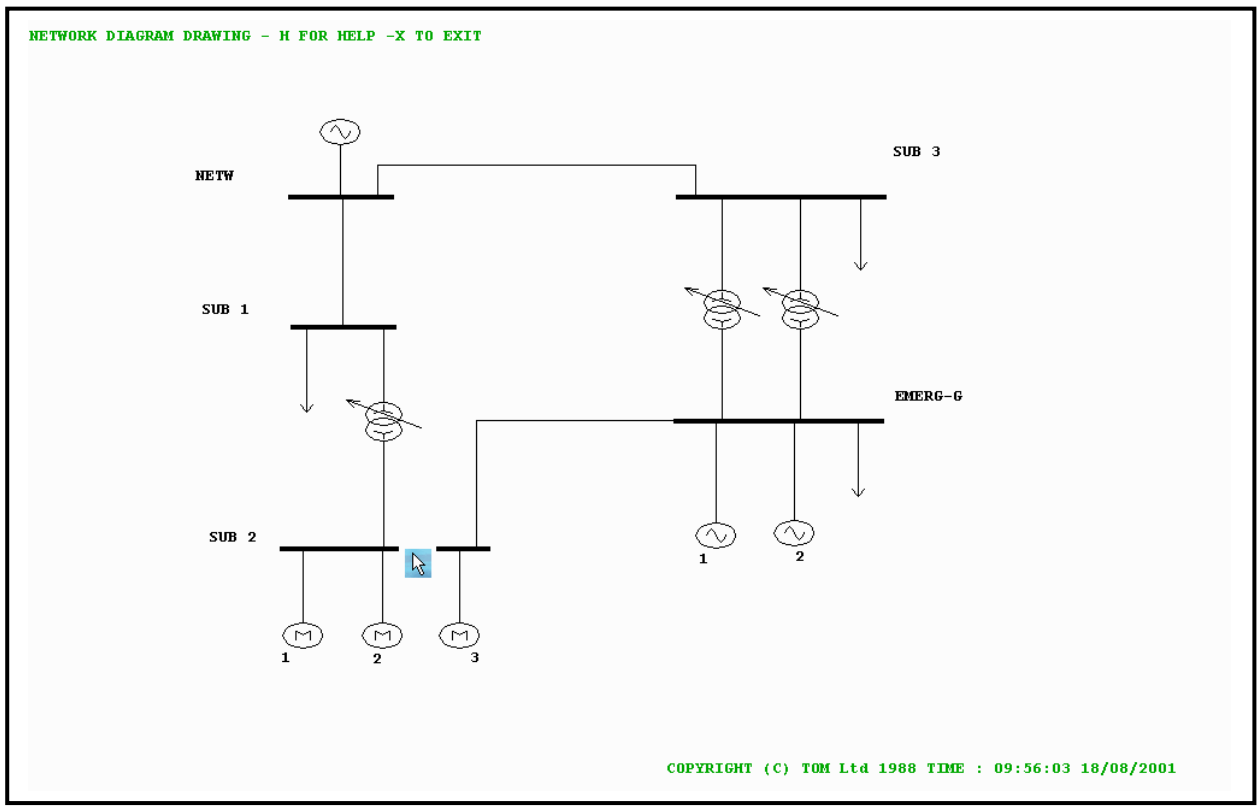


Figure 3-60

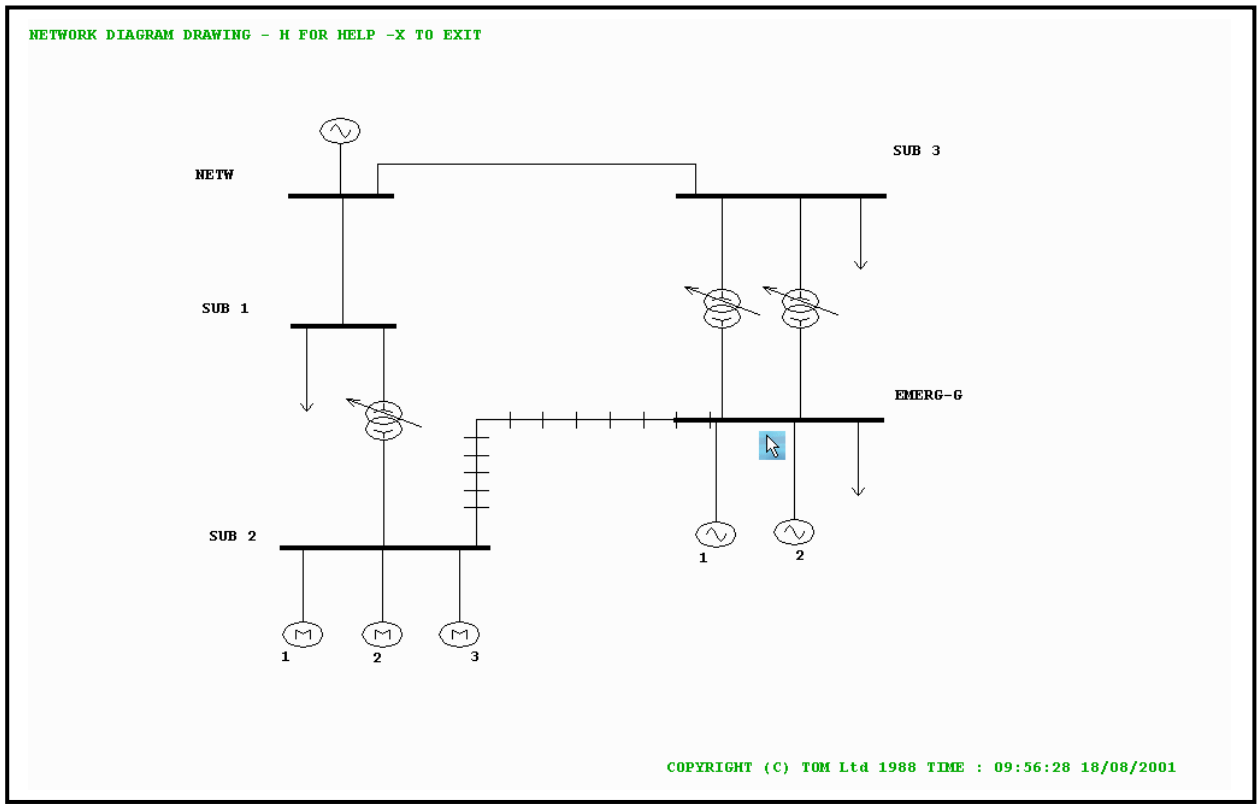


Figure 3-61

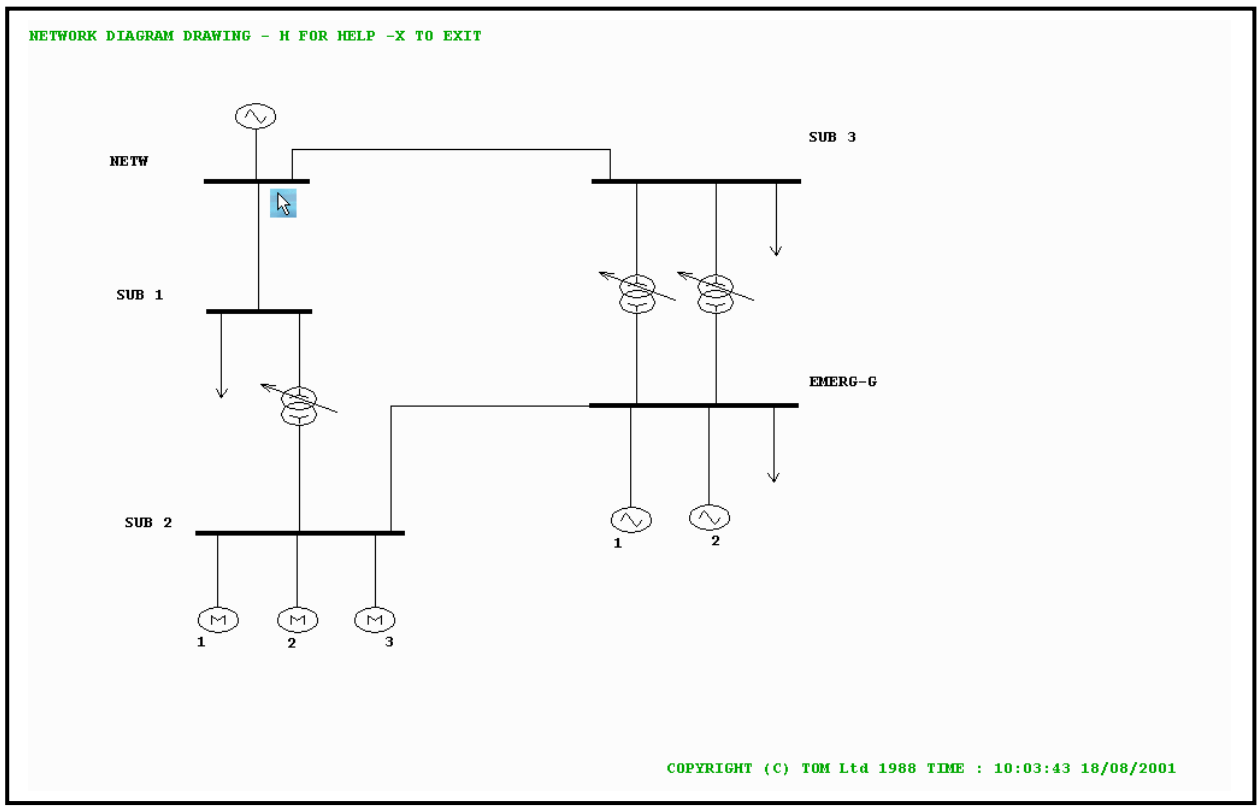


Figure 3-62

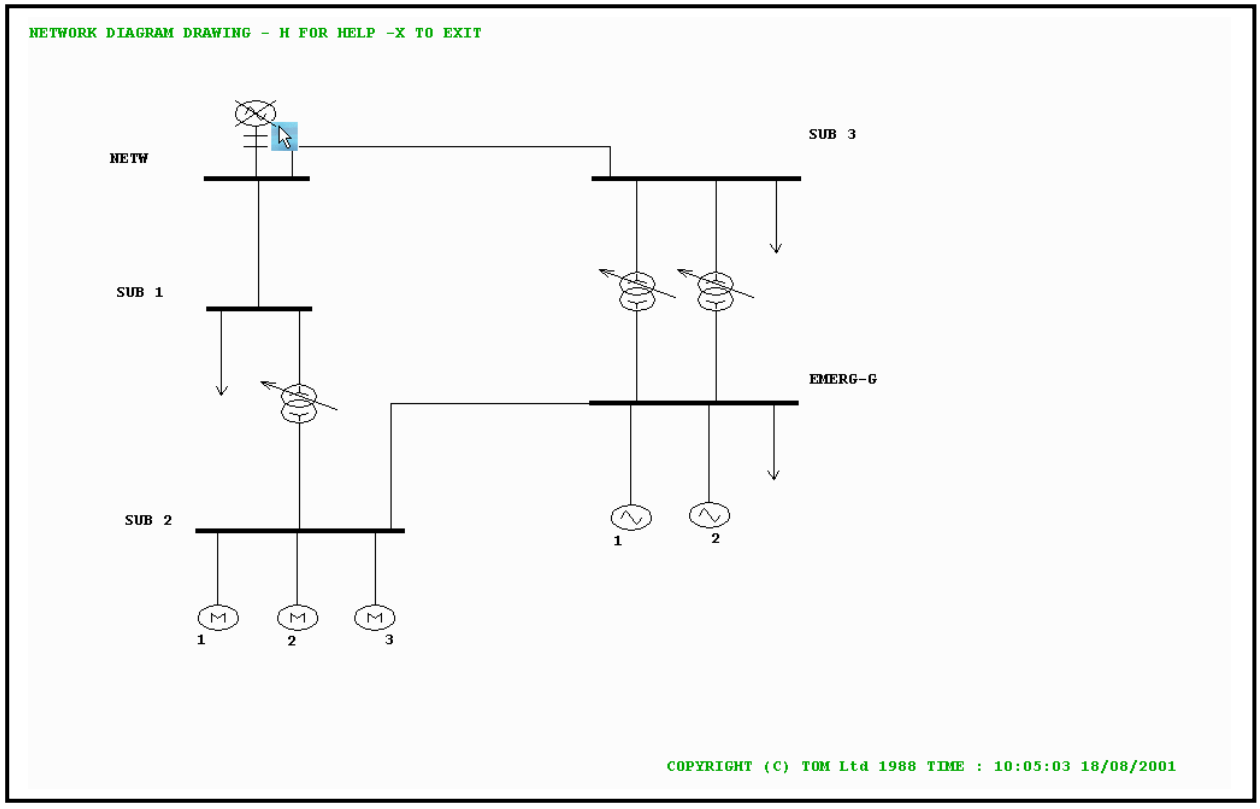


Figure 3-63

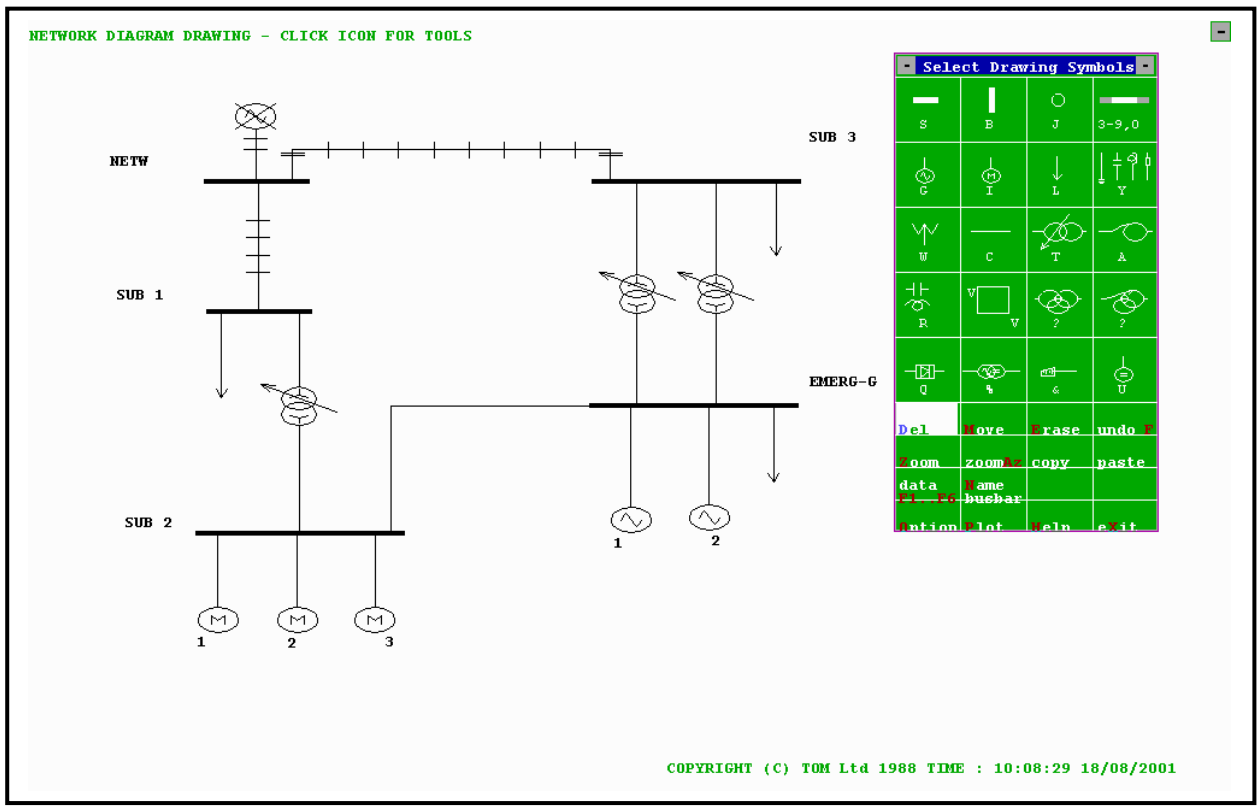


Figure 3-64

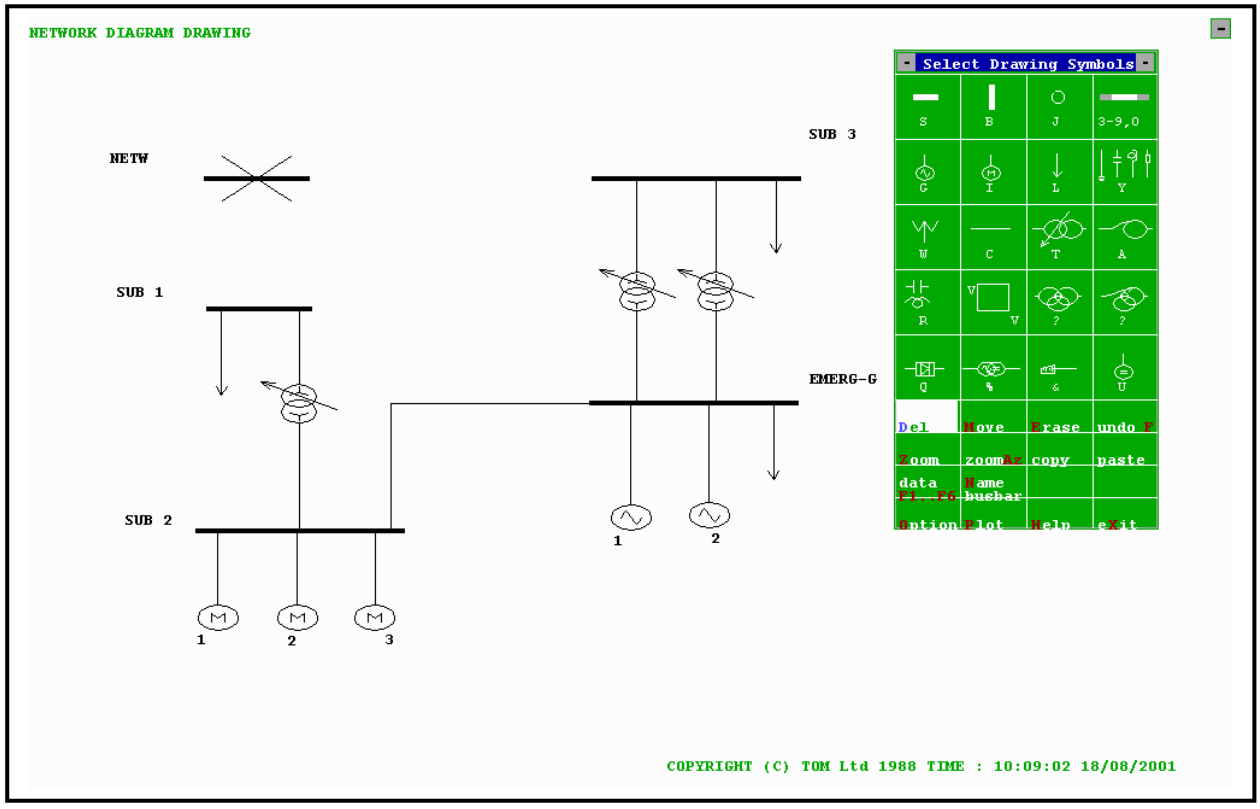


Figure 3-65

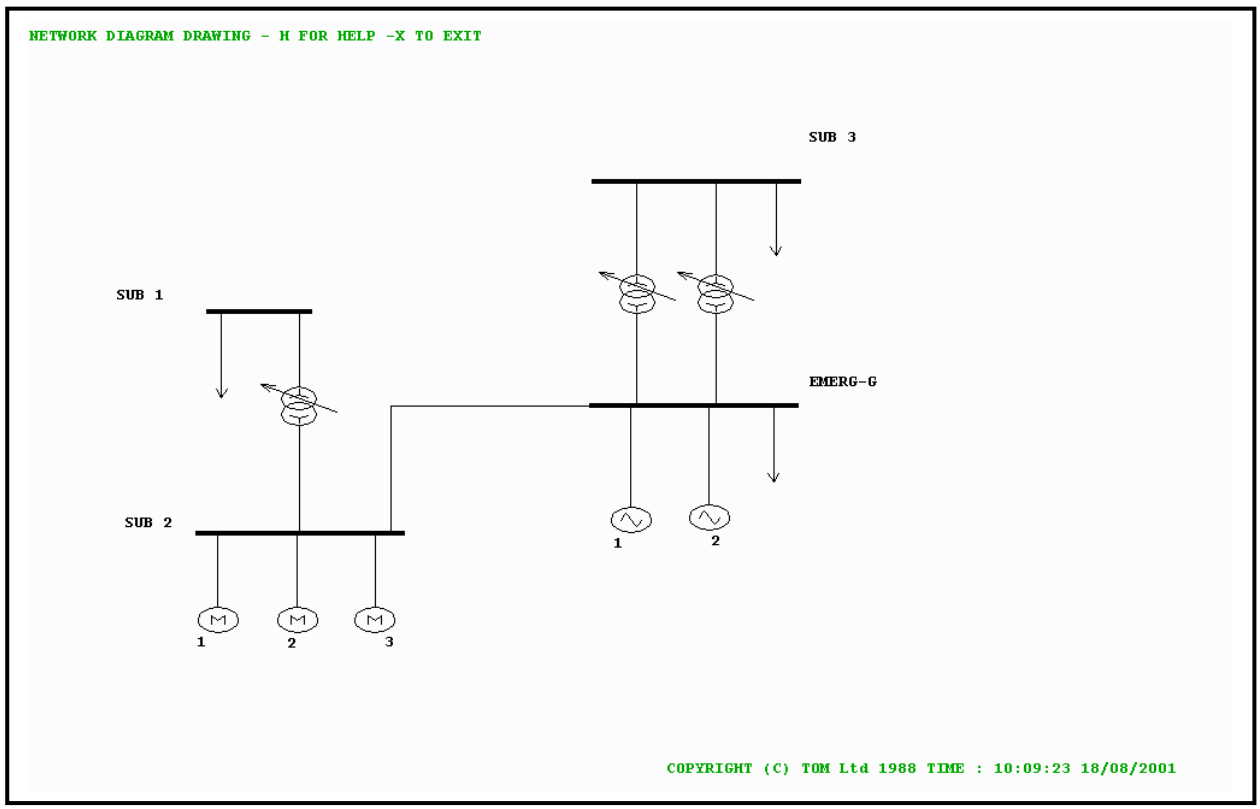

NETWORK DIAGRAM DRAWING - H FOR HELP -X TO EXIT
SUB 3
SUB 1
EMERG-G
SUB 2
1
2
M
1
M
2
M
3
COPYRIGHT (C) TOM Ltd 1988 TIME : 10:09:23 18/08/2001

Figure 3-66

3.5.2 Move mode

The <M> key is used to start 'move mode', which enables the user to move any of the network elements that he has previously drawn. To enter move mode using the keys, it is necessary to first position the cross-hair cursor over the required substation or junction at which the move process is to commence, and type <M>, i.e. it initiates move mode for the repositioning of any number of network items connected to that substation. After pressing the <M> key, the elements are selected for movement by using the normal key codes used to draw them, i.e.

<L> to move a load

<W> to move an infeeding transformer

<Y> to move a shunt

<G> to move a generator

<I> to move an induction motor

<N> to move a substation (or junction) name

For the above elements, the position at which the cursor lies when the key is depressed will be the new position of that element.

It is also possible to enter move mode by positioning the cursor over a particular plant item connected to a substation and typing <M>. This enables the user to specify which generator will be moved, if more than one are connected to the substation.

If you are using the tool bars, then the process is somehow simpler. In this case just select the MOVE from tool bars, this puts the computer in the move mode. Then you must select the required plant by a click and move the cursor to the new position and click again. This may include the lines or transformers, which have turning points.

Figures 3.67 and 3.68 show an example of moving a radial item. The cursor is first positioned over the generator and an <M> typed to enter move mode as shown in figure 3.67. The cursor is then moved to the desired position and a <G> is pressed. The generator is then moved as shown in figure 3.68.

<S> to move a substation or a junction. If junction it becomes substation.
<J> to move a junction.

In the above two commands it is first necessary to position the cursor at the new point for the substation or junction symbol before depressing the key. Also any items connected to the moved substation will not be shown moved

At this stage, the substation will be drawn correctly, connected to the new location, if the diagram is erased and redrawn for any reason. This can be done, when required, using the:

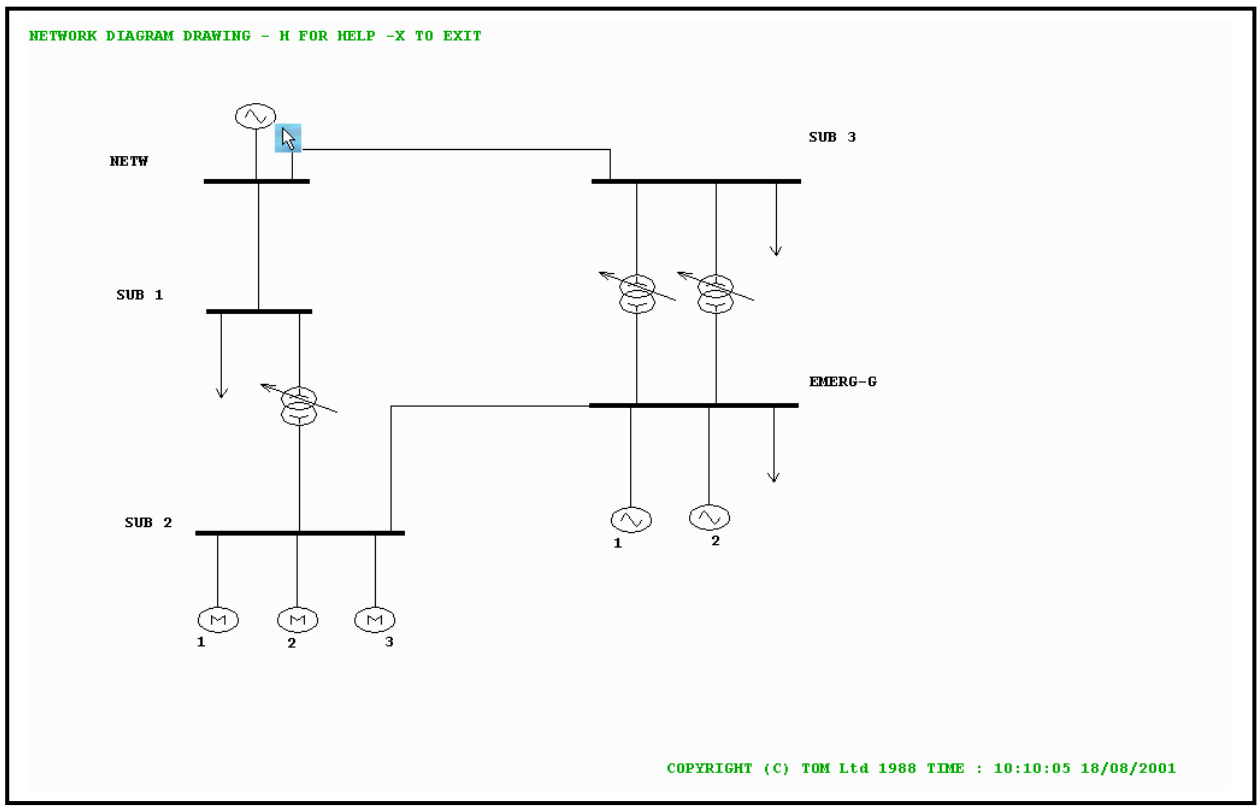


Figure 3-67

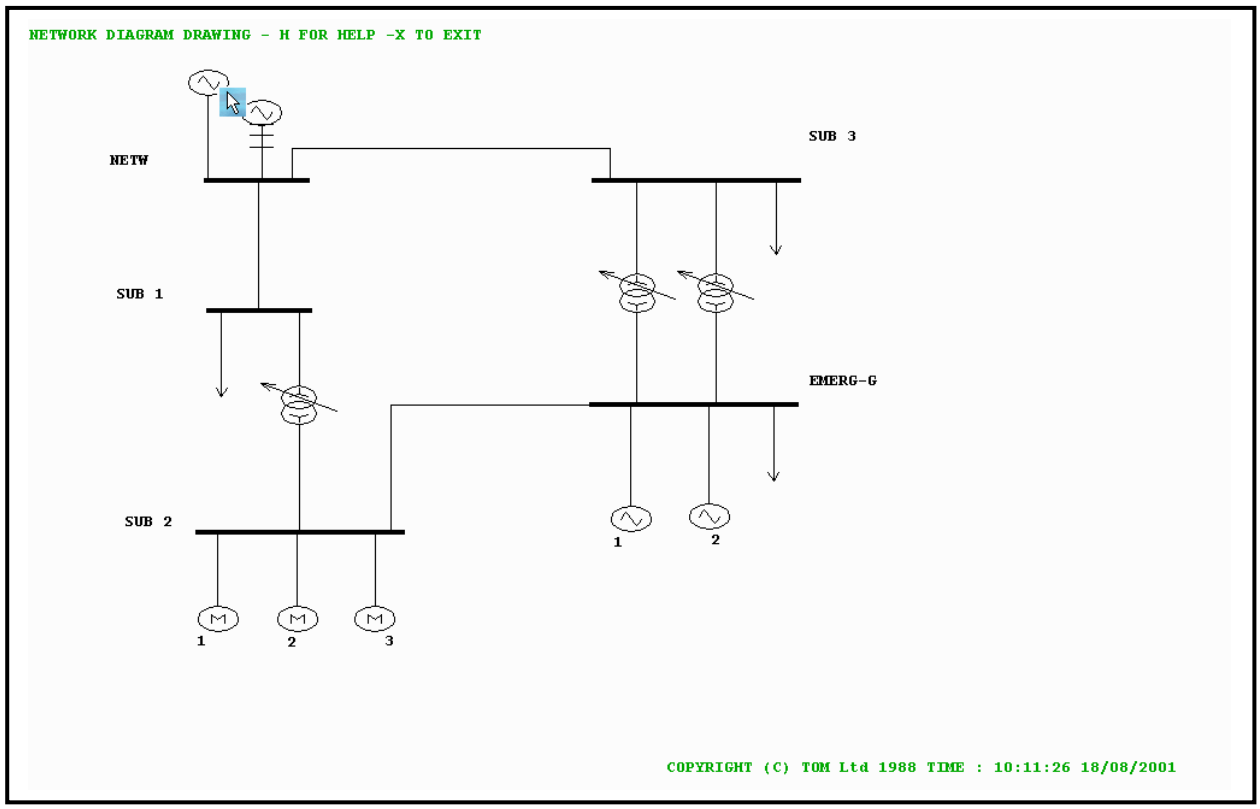


Figure 3-68

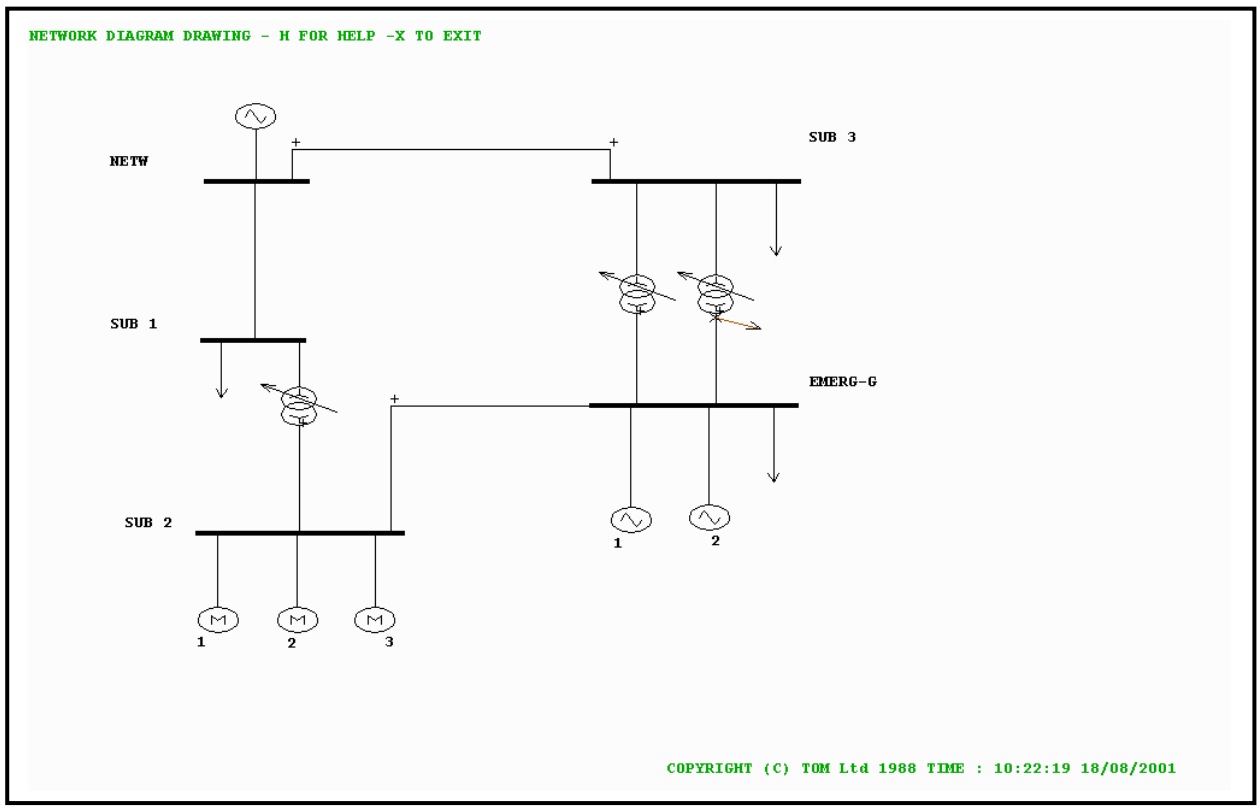


Figure 3-69

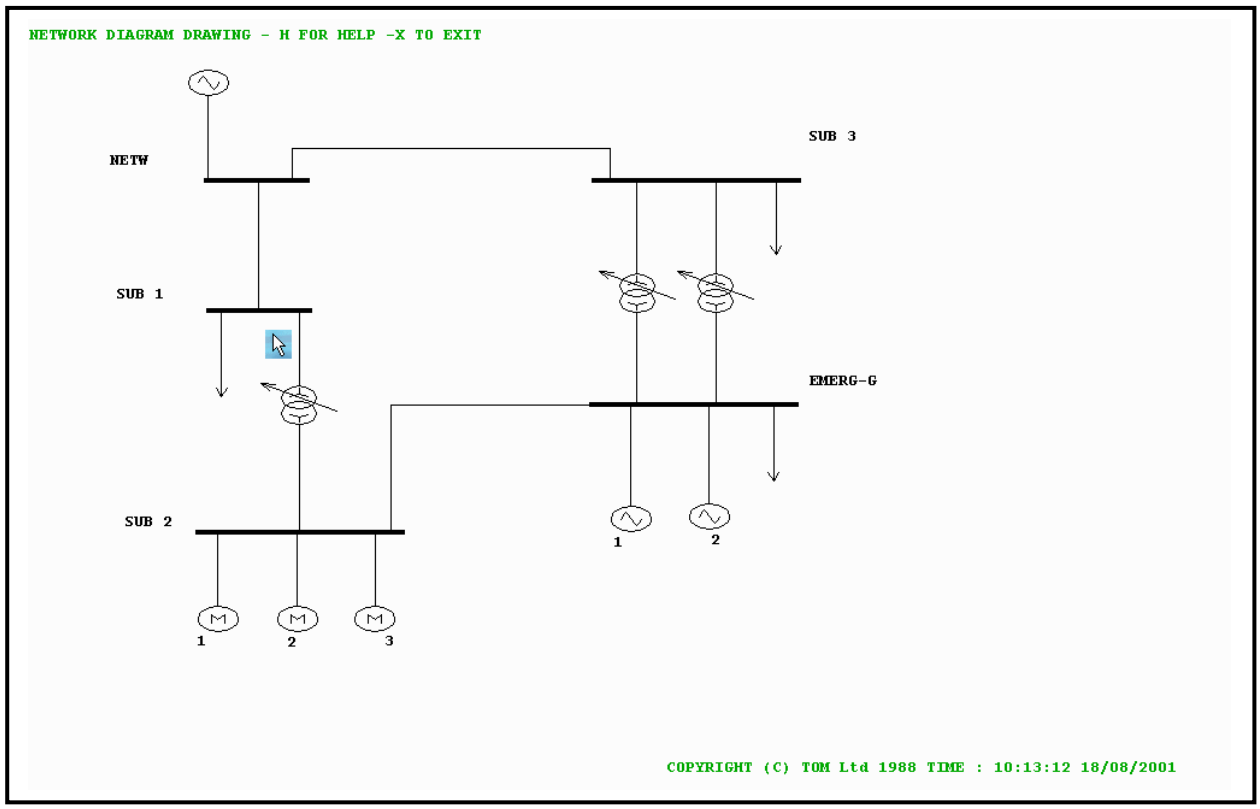


Figure 3-70

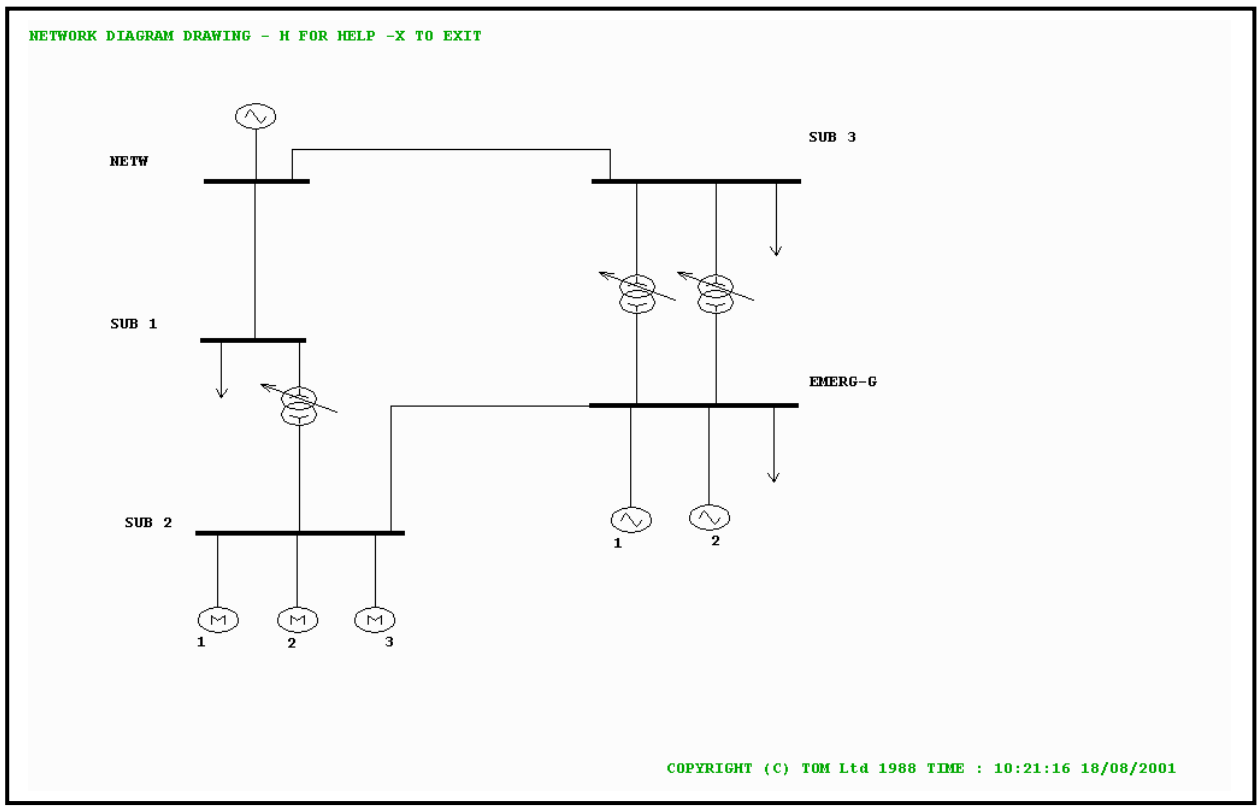

NETWORK DIAGRAM DRAWING - H FOR HELP -X TO EXIT
NETW
SUB 1
SUB 2
SUB 3
EMERG-G
1
2
3
1
2
COPYRIGHT (C) TOM Ltd 1988 TIME : 10:21:16 18/08/2001

Figure 3-71

<E> command or select erase from tool bars.

Figures 3.69 - 3.71 show the movement procedure for a substation. The cursor is positioned over the substation SUB 1 as shown in figure 3.69 and the <M> key is pressed. The cursor is then moved to the new position and the <S> key is pressed. Figure 3.70 shows the result of this, the substation symbol is redrawn at the new position and a dotted arrow shows that this is a moved substation not a new one. The <E> key is then pressed to show that the substation has moved as shown in figure 3.71. Its associated plant, however, does not move; the position of the load is the same as before, only its connection line has been moved. In order to move the load you must use the move for Load symbol i.e. press <L> after selecting the move. This is also true when you use the tool bars.

<T> to move a circuit and (including those incorporating transformers, and/or reactor symbols etc.) and transfer its data.

It is first necessary to re-position the cursor at the opposite end of the required circuit, or over a turning point in the required circuit. At this stage the circuit has, in fact, been deleted, but all the network data is being stored temporarily. If a new circuit is now drawn anywhere on the network, before any deletions are made, then it will have this stored data associated with it.

<P> to move the turning point of a line (circuit) segment (use mouse right click and select turning points to see them with a + sign after redisplaying the diagram)

If a circuit between two substations (or junctions) is composed of more than one segment, it is possible to move the turning point of the individual segments. In this case the <M> key to initiate move mode must be pressed when the cross hair cursor is positioned over the turning point to be moved. The <P> key is then pressed with the cursor positioned at the desired new turning point for the circuit segment.

The process of moving a knee point, which moves the entire lines connected to this, is somehow simpler by selecting MOVE from tool bars. You may then select the line by clicking over the required section and then click in the new desired position.

Figures 3.72-3.75 show some examples of moving a connection segment. The point to be moved is selected by positioning the cursor over it and typing <M> as shown in figure 3.72. The cursor is then moved to the new position for the point and a <P> is pressed. The point is then shown to have moved using a dotted arrow to the new position as shown in figure 3.73. If the diagram is then redrawn the moved point can be seen, as shown in figure 3.74. As this looks a little uneven the other two connection segments (the busbars) can then be moved, or the busbars may changed to bigger size by pressing <4> as shown in figure 3.75, to produce a more balance diagram.

Any command which cannot be accommodated by the program as 'move' brings the user out of the 'move' mode. For new users the most satisfactory way to exit from the 'move' routine is to press the space bar. This produces the message: 'Code not recognized - please try again' and gives a clear indication that the normal drawing procedure has been re-entered.

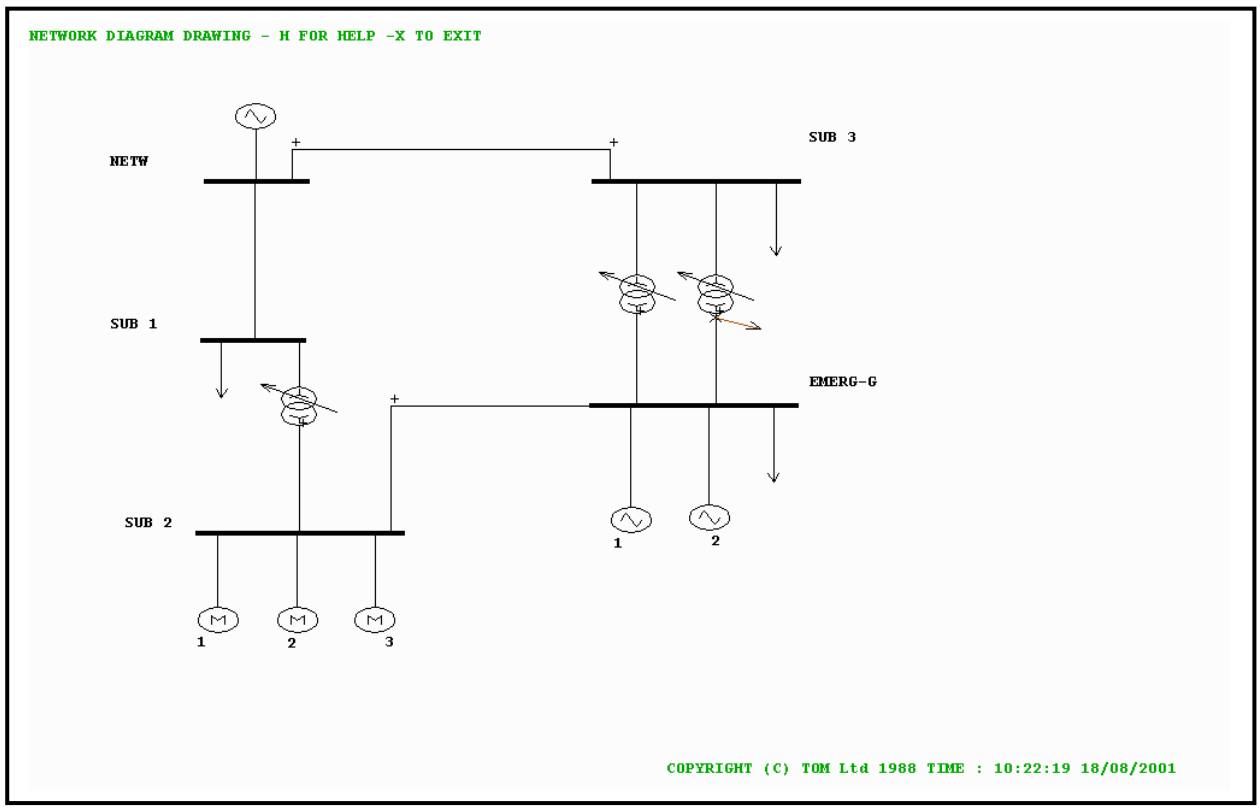


Figure 3-72

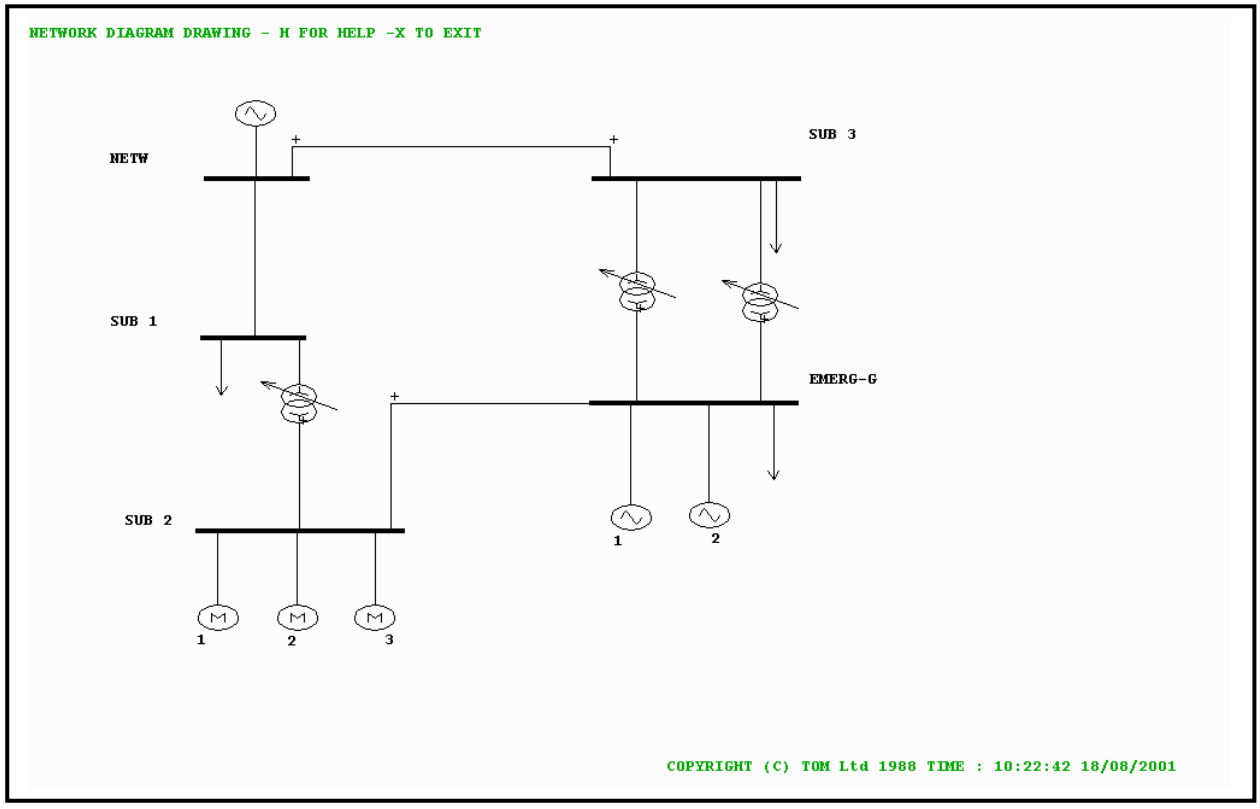


Figure 3-73

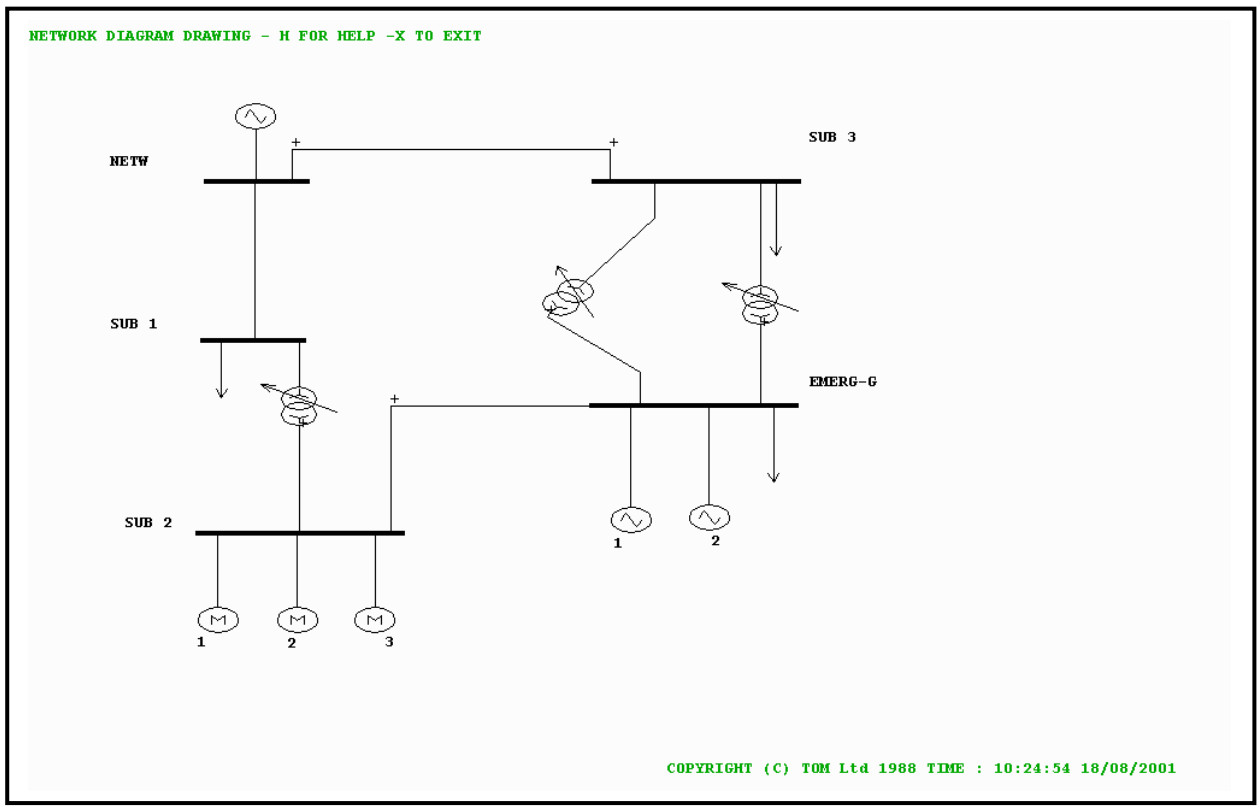


Figure 3-74

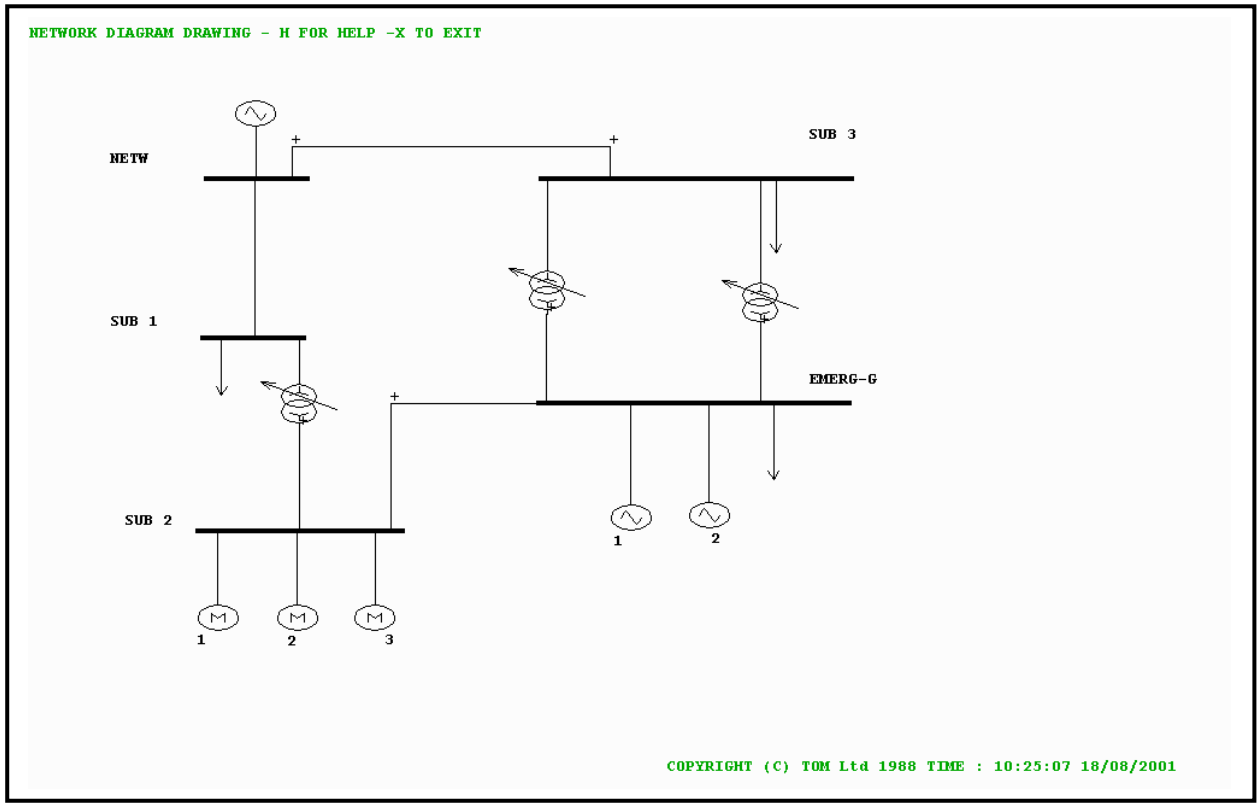


Figure 3-75

3.6 PLOTTING

Pressing <P> key while the cursor is over an empty position, sends the entire diagram (inside the screen and outside of the screen) to a plotting file which is named PASHA----.plt where ---- represents a sequence number. This file can be plotted later by running PLOT.BAT under DOS command, or clicking on PASHA PLOT under the Windows platforms, please refer to chapter 20.

3.7 WINDOWING

Windowing is an additional graphic facility, which permits to create graphic boxes in the drawing page. Although window is just a box, it is a very powerful graphic item for large scale power system networks. It helps the user to relocate the diagram in any position by pressing the <Z> key for zooming. It also lets the user to move or delete a part of an area. In case of deleting you may also choose to introduce the electrical equivalence of a part of a network. Therefore, it is advisable to use this item in your drawings to divide the single-line diagrams to areas. You may find out the usefulness of this item when you are working with the example networks of PASHA locating in NETWORK folder.

Each window has a graphic 'scale' and a name. The size of the elements which are drawn inside a window box will be rescaled to the window 'scale'. In this way a part of an area (which is in minor importance) may be shown in small size while the others can be represented in bigger size.

The following keys can be used to create window boxes:

<V> choose the right hand corner of a window box, or make an existing window active.

<V> pressing <V> again, draws a window box from right hand corner to the selected left hand corner. Before drawing the box, the computer asks for the name and the scale of the window. The names are always appear in the right hand corner of the window box opposite to the fist corner selected for drawing the window.

The window boxes can be modified by first selecting the window (pressing key <V> on an existing window) and then using the following keys:

<D> to delete a window (with or without its associated network elements).
<C> to copy a window (without its associated network)
<R> to paste a window which is copied before on some other places
<N> to rename a window
<S> to rescale a window
<M> to move a window with all its associated network elements to a new position.
<A> to add a previously stored network to the existing network. After pressing this key on an empty window, the retrieving facility which is described in chapter 5 will be entered. The user can then select his desired network to add to the existing network inside the selected window. The scale of the window will be automatically set to adjust the retrieved network dimensions.

<U> updates a part of diagram. It is a sort of combination of the <D> and the <A> keys. It is useful for those who are working in two parts of a large network. For example, one user works on a 63KV and 20KV and the other works on 400KV, 230KV, and 132KV. They can update the each other networks.
<1> Busbar names and the results will not be displayed inside the selected window (its action disregarded in ZOOM state, see below for ZOOM state)
<0> Busbar names and the results will be displayed inside the selected window (default)
<2> press this key inside a window to see the total generation of the generators inside that window in load flow study.

Figure 3.76 shows the network of figure 3.51 diagram which three windows are created on it, while the scale of an existing window is going to be modified.

The <Z> key can be used to zoom inside a window. Locate the cursor inside a window and press <Z>, the selected window will be zoomed on the screen. Otherwise if the key is pressed outside the windows the name of the required window will be asked. Pressing a click or any key will unzoom the network and will be back to the initial configuration. This facility can also be used in all the study modes of PASHA and whenever a single-line diagram is on the screen. Please also refer to chapter 2 for right click.

Figures 3.77, 3.78 displays the addition of a network capability of PASHA. Figure 3.77 shows the screen after the user has selected a network to be added inside an empty window. Figure 3.78 shows the network that is merged inside the previous network. This is one of the powerful tools for construction and simulation of a multi area large-scale electric power system. For example you may add a steel mill plant with all its elements inside a large scale interconnected network and delete it in order to put the equivalent of the steel mill inside the grid. Computer asks you, if you like to put the equivalent before deleting an entire area. Figure 3.79 shows the questionnaire for deletion of an area located in a window.

3.8 Graphics Scroll bars

Horizontal and vertical scroll bars move the single-line diagram to the left and right, or up and down. The Home, End, Page Up and Page down may also be used to recentre the single-line diagram. The arrow keys are also function for moving the single-line diagram around but move the diagram in smaller steps.

3.9 Colorful diagrams:

Figure 3.80 shows the previous network where the colors of the busbars are specified. The colors of the elements are automatically obtained from the V-NOM-KV value as are entered and described in chapter 4 section 4.5.1. Please also refer to section 2.5.15 in chapter 2.

3.10 Large scale plants:

Figure 3.81 shows a steel mill plant drawn by PASHA. The state of the art of drawing using the simple keys just described is obvious.

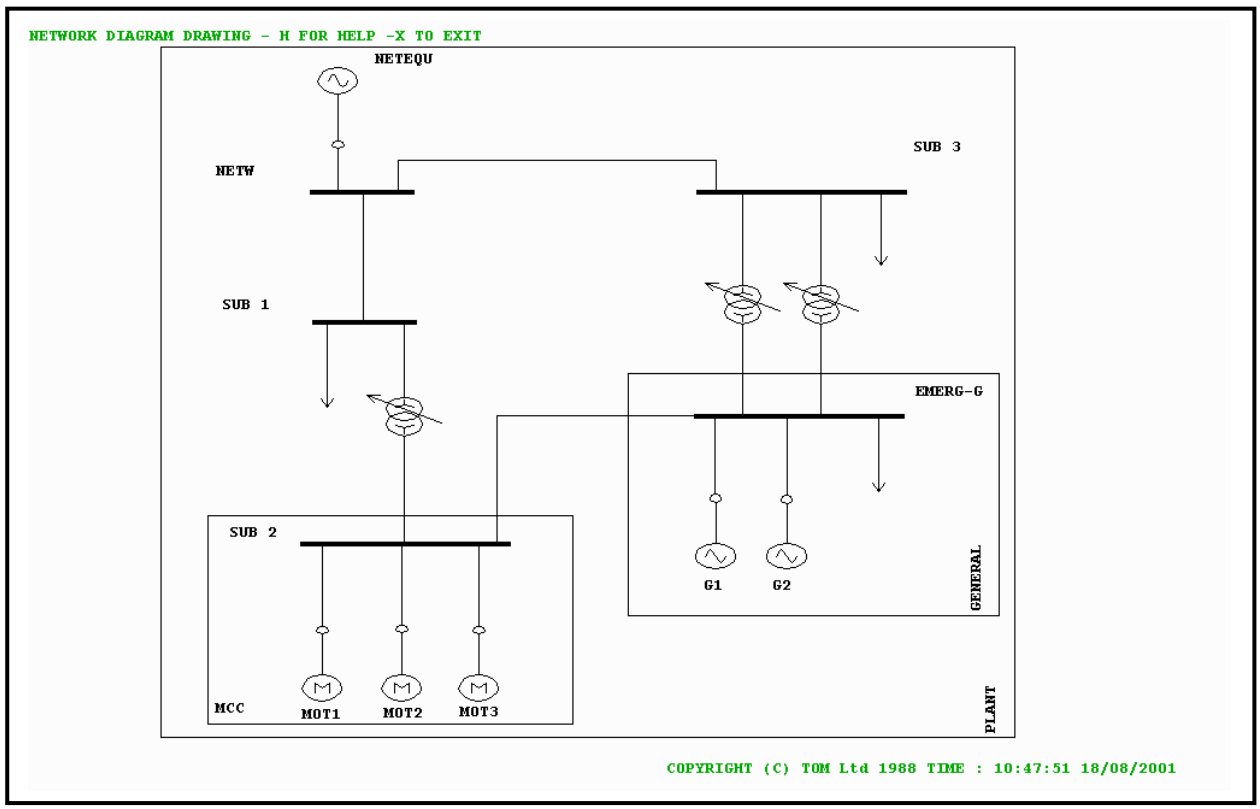


Figure 3-76

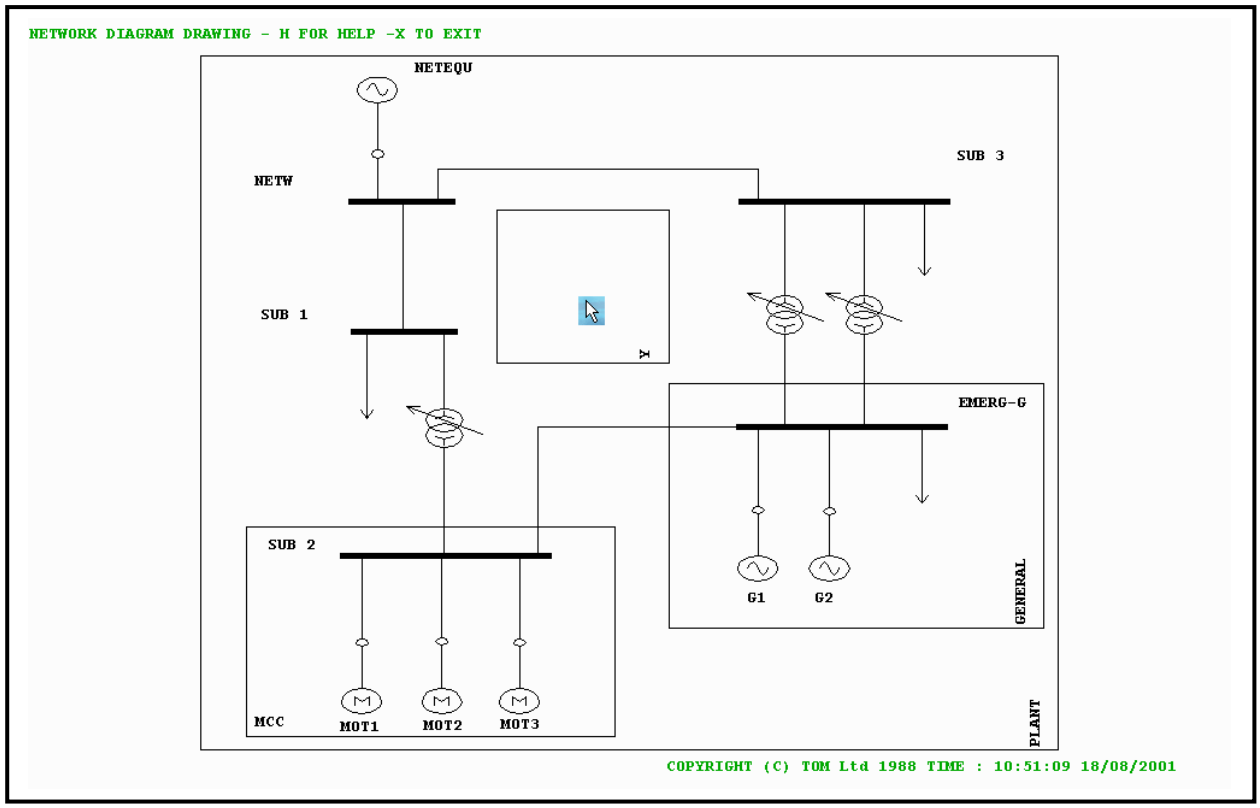


Figure 3-77

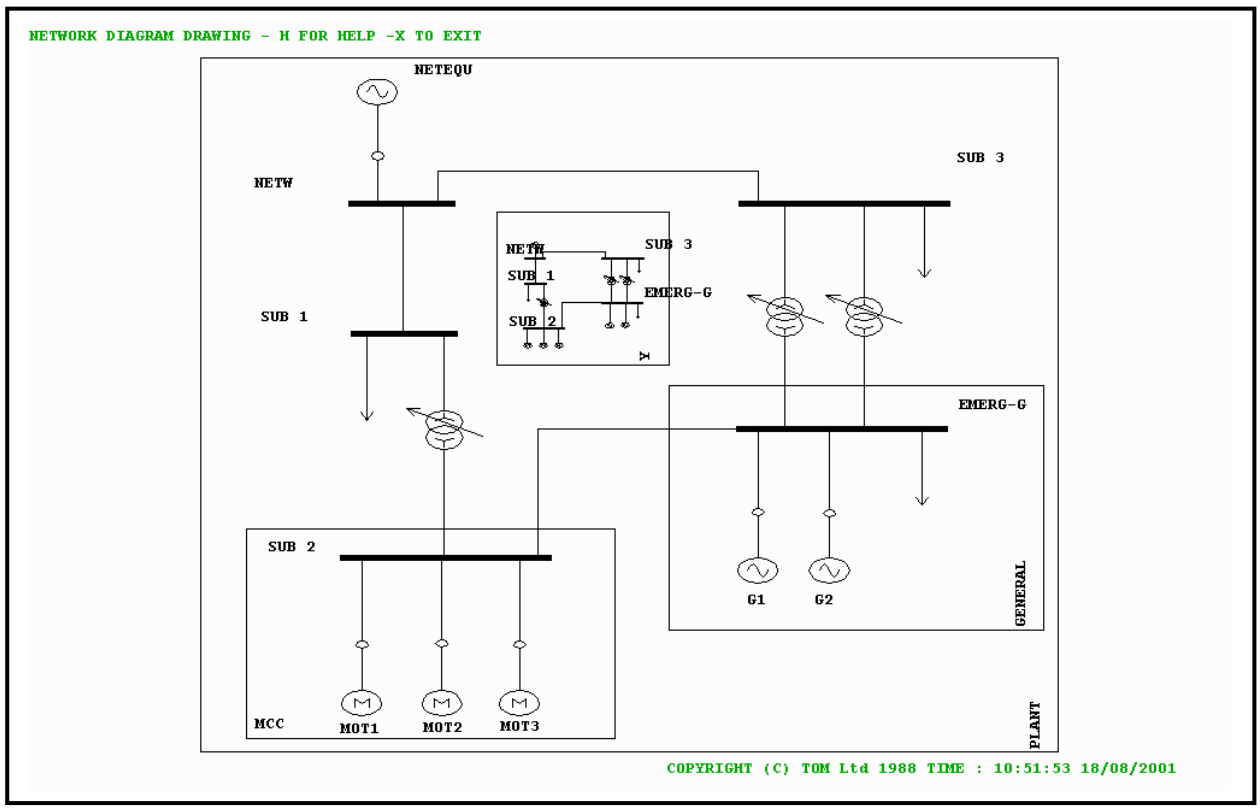


Figure 3-78

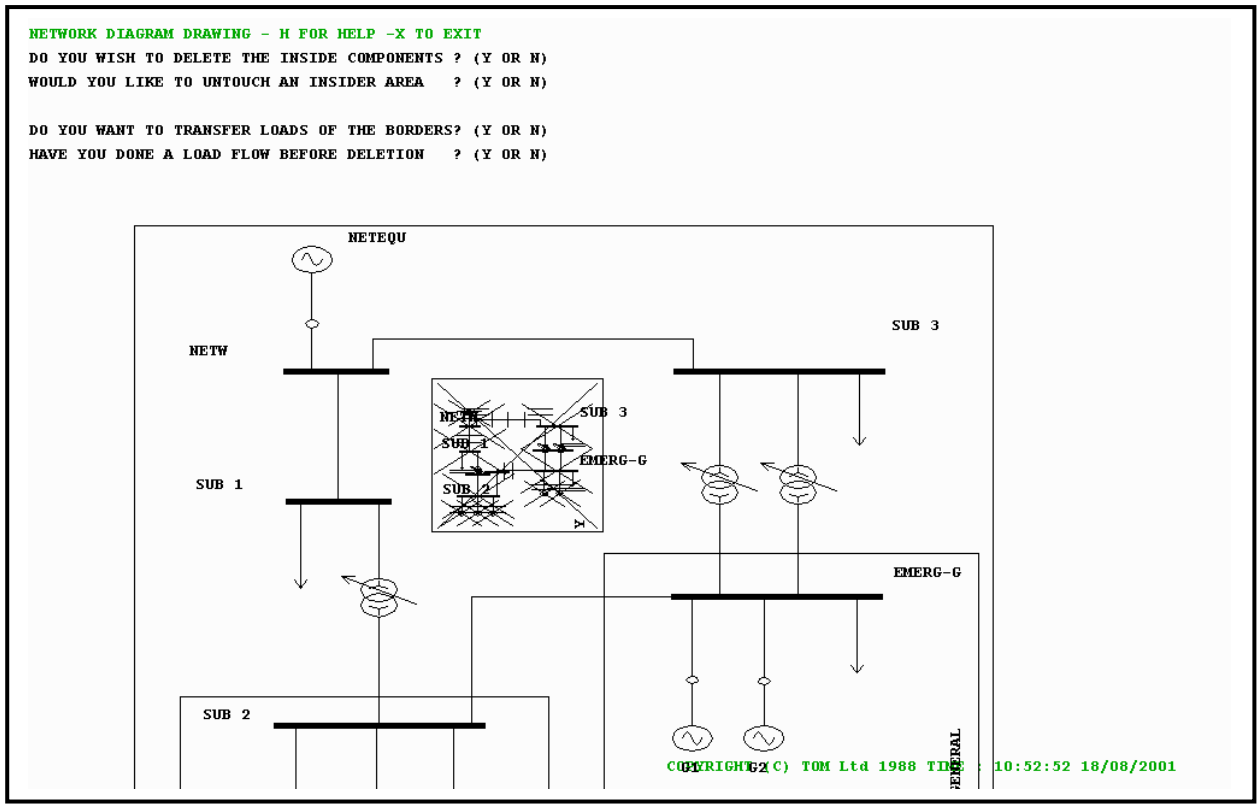


Figure 3-79

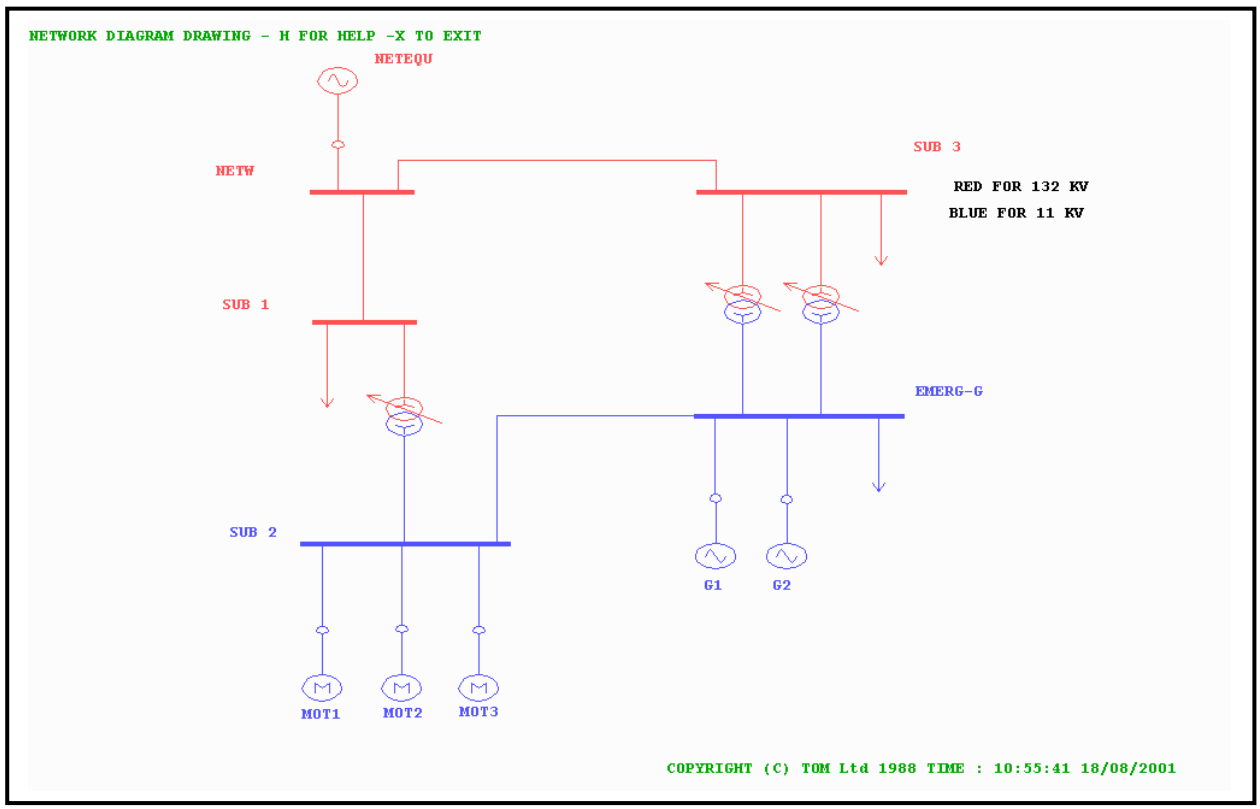


Figure 3-80

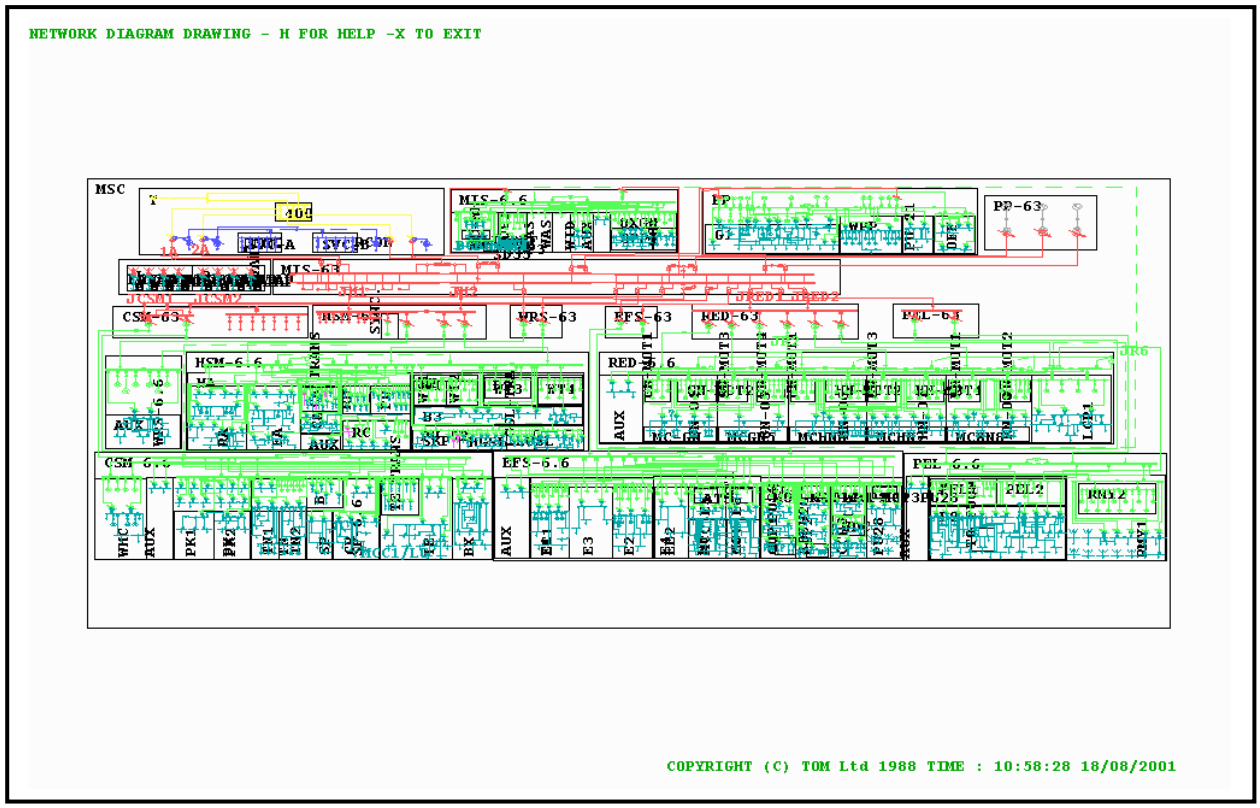


Figure 3-80

3.11 Summary

Using the draw keys defined in the drawing section it is a simple matter to draw a network diagram. Upon entering the drawing section the program enters 'drawing mode' in which the cross hair cursor can be considered as an 'intelligent paintbrush'. The cursor can be moved over the screen to the desired position, and a defined key pressed to draw a symbol at that position. A full range of keys is defined to allow drawing of all the necessary power system plant symbols.

After drawing substation and/or junctions and their associated plant, it is then possible to connect them using circuits containing in line plant such as transformers etc.

At any time in the drawing process corrections or changes can be made by entering either 'deletion mode', or 'move mode'. In the first of these, it is possible to delete any previously drawn elements. The second enables previously drawn plant and connections etc. to be moved to a new position on the diagram.