D. C NETWORK ANALYSER

OBJECT:

To study the use of a D.C network analyser for fault calculations.

THEORY:

Fault currents & fault MVA must be known for the appropriate part of a supply system when selecting circuit breakers. Values can be found analytically but the calculations become tedious as the system becomes more complicated.

Under fault conditions the system is largely inductive so that it is practicable to neglect the system resistance and capacitance. If the generators in the system are assumed to be in phase and equal in output to the system voltage, they can be represented by a single D.C. supply in a circuit, which uses resistance to simulate the system inductance. Normal system currents are assumed negligible. Only in-feeds are included in the fault calculation, feeders are neglected.

In the model 10 V D.C = 1 pu system voltage and 1 ohm = 1% inductive reactance at 100 MVA. The choice of these values means that 1 mA of fault current on the calculating board corresponds to a system fault level of 1 MVA.

NOTE: A calculating board may be constructed by applying +/-10 V DC from a power supply to the positive and negative terminals on the board that correspond to each of the generators. The generator, line, and transformer reactances may be represented on the board by variable radio resistance potentiometers of appropriate values. Before proceeding with the study, each of the component pu reactances must be converted to a common base and thence to a reactance value in ohms. The potentiometers may be adjusted to correspond to each of the component reactance ohmic values. The generator terminals and the appropriate potentiometer terminals (which correspond to the various components) may be inter- connected to correspond to the actual power system being investigated for fault studies.

REFERENCES:

Electrical Power Transmission & Distribution by P.J. Freeman
Electric Power System by B.M. Weedy

CALCULATION PROCEDURE

1. Bring all system components % reactances to a common MVA basis;e.g.if a transformer has a reactance of 10 % and is rated at 30 MVA, then the reactance to a 100 MVA base is equal to 10*100/30 = 33.3 %
2. Reduce the system diagram to a single generator feeding the fault through a single reactance. Since the generator phasor e.m.f's are assumed equal, all the generators may be replaced by a single generator of zero reactance, feeding the network through all the actual generator reactances. Having found the single equivalent reactance , the short-circuit MVA fed into the fault is calculated from short-circuit MVA = Base MVA* 100/Equivalent % reactance
3. Show the calculations and tabulate the reactance values for the items of plant.

ANALYSER PROCEDURE

The calculating board has jack-plug sockets adjacent to each item of plant. (The reactance of each item of plant is simulated by resistance potentiometer, which may be adjusted by turning its knob so that its resistance as measured by the multimeter corresponds to the plant reactance). The socket connections are normally closed internally. To include a piece of equipment a jack-plug containing the equivalent D.C resistance must be inserted at the appropriate point. A circuit may be made open-circuited by

inserting a jack-plug with no resistor. The supply voltage (from a D. C power pack) may be adjusted to 10 V. Tabulate the equivalent resistance for the different items of plant.

1. Set p the system shown in the Figure using the values derived from your calculations. Place a fault in the busbar at sub-station 4. Measure the short-circuit MVA at each circuit breaker. Show the magnitudes and directions on a circuit diagram.
2. Remove the reactors and solidly couple the generator bus bars. Repeat step 1.

RESULTS

Calculate the short-circuit MVA for each case and compare with measured values. What effect does the removal of reactors have on the S.C MVA between the generator bus bars? Calculate the two currents flowing into sub-station 4.

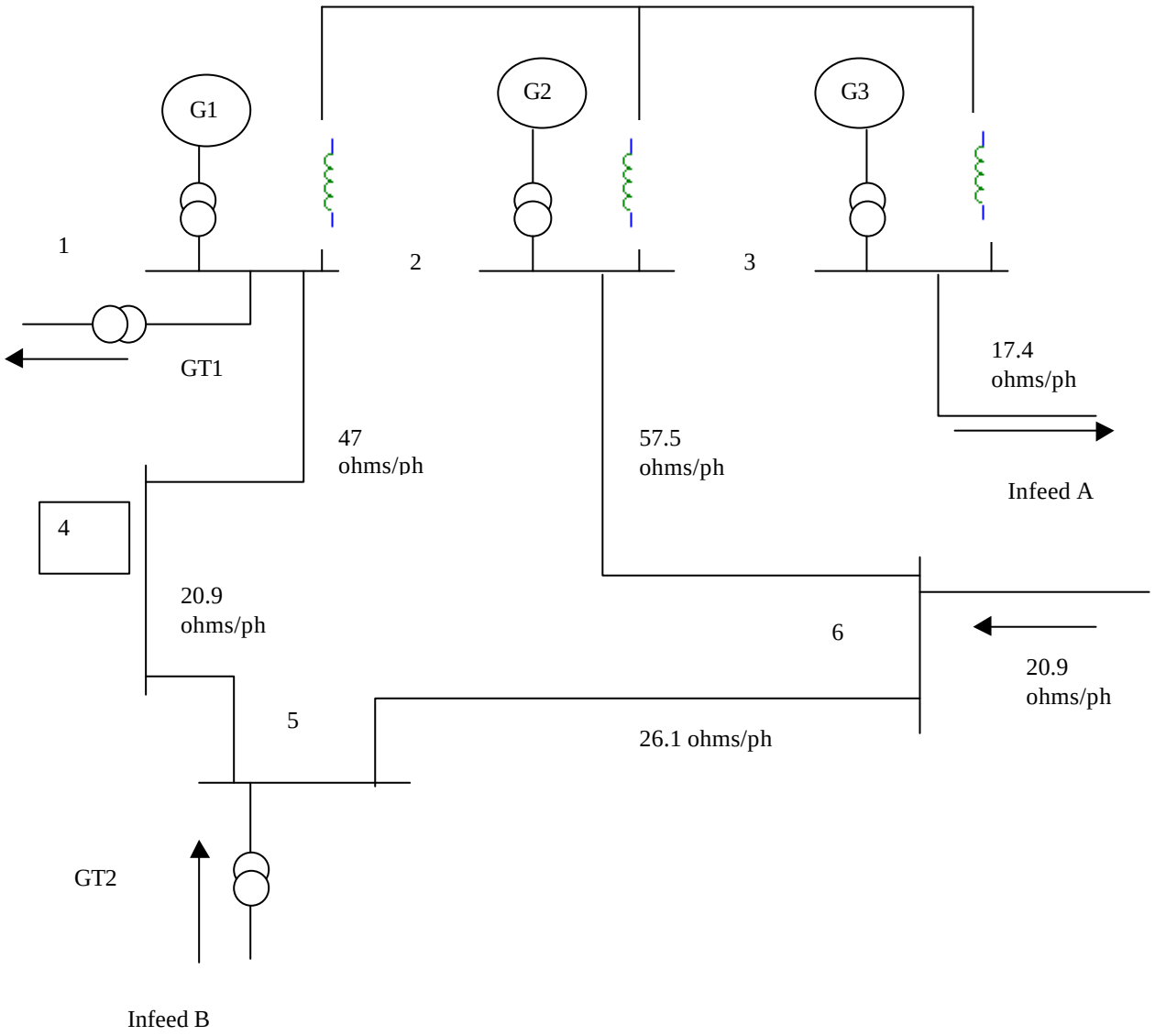
CONCLUSIONS

Compare the results with the calculations.

SYSTEM DIAGRAM ***is shown in FIG. Below(next page)***

Line Voltage- 132 kV
Line reactances as shown
Generators- 25% at 25 MVA
Generators Transformers- 12.5% at 25 MVA
Reactors-10% at 25 MVA
Grid Transformers-1. 20% at 40 MVA
2. 12% at 30 MVA

Infeeds -A. 100MVA
B. 25 MVA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