PSL30

Transmission Line Simulator

User Guide

TecQuipment has taken care to make the contents of this manual accurate and up to date. However, if you find any errors, please let us know so we can rectify the problem.

TecQuipment supplies a Packing Contents List (PCL) with the equipment. Carefully check the contents of the package(s) against the list. If any items are missing or damaged, contact TecQuipment or the local agent.

AB/DB/bs/BW/0717

TECQUIPMENT

Symbols used in this manual

NOTE	*Important information.*
CAUTION	*Failure to follow these instructions can damage the unit, other equipment, personal property or the environment.*
WARNING	***Failure to follow this instruction may cause injury.***

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Introduction and Overview

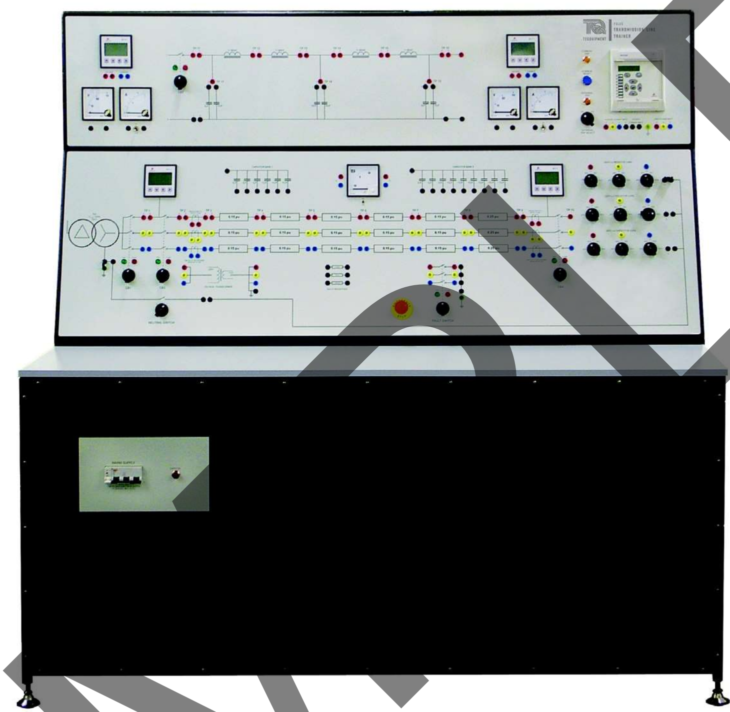

Figure 1 The TecQuipment Transmission Line Simulator (PSL30)

Overhead transmission lines are the most commonly used method of transferring power from one location to another, usually without interruption. A.C. lines have always been most popular because its easy to transform high voltages into lower ones. However, improvements in technology have resulted in competitive d.c. transmission schemes over certain minimum distances, where a.c lines can be expensive.

The Transmission Line Simulator is a fully equipped module that examines the performance and characteristics of single and three-phase lines. It examines the nature of transmission lines, and the transmission line as a power system component.

The Transmission Line Simulator includes two types of transmission lines to allow students to do two types of experiments. It has a single phase line that connects to show a nominal T and Π representation. It also has a three-phase line with series and shunt reactances given in 'per unit' form. The single-phase line allows students to examine the accuracy of T and Π representations. The three-phase line allows students to do basic power system experiments, such as load and fault studies.

The Transmission Line Simulator is also one of the five Modules that form the Power System Laboratory. This system allows the Transmission Line Simulator to connect to other components such as a generator and transformers. This extends the experiments that students can do. At the end of this section is a brief description of the Power System Laboratory.

Experiment 1: Single Phase Line - Short Line Investigation

Aims

To find the regulation and transmission of a simple inductive line without shunt capacitance, and to construct the relevant phasor diagram.

Notes

You use a short section of the line with only two inductive elements. The line has a 'send' end (to the left) that connects to the supply, and a 'receive' end (to the right) that connects to the loads.

Procedure 1 - Resistive load

1) Create a blank table of results, similar to Table 5.

2) Connect the circuit as shown in Figure 34, but only select a 100% resistive load (L1).

3) Shut CB1 (at the secondary of the supply transformer) and CB2 (at the 'send' end of the single phase line). This connects power to the line with a current of roughly 5 Ampere.

4) Use the analogue voltmeter to measure the voltage drop (Vd) across the line impedance. Use the multifunction meters to measure the sending and receiving end voltages, currents and power. You can also use these meters to show power factor, but for good practice, use Equation 5 to calculate the power factor for each end of the line. The sending end voltage should remain fairly constant - determined by your local mains supply and cables.
Why is the voltage drop (Vd) not equal to the difference between the sending and receiving voltage?

$$\text{Power Factor } (\phi) = \frac{W}{VI} \qquad (5)$$

5) Use your results to find the line regulation and transmission efficiency.

6) Construct a short line phasor diagram as shown in the theory section and use it to find the effective values of line resistance and reactance ($I_R R$ and $I_R X$) for your recorded load current (receive end).

7) Use your results to calculate the actual value of inductance and compare it with the values written next to the inductors of the single phase line.

Voltages, Currents and Powers	100% Resistive Load	100% Resistive Load + 50% Inductive Load
Sending Voltage (V_s)		
Sending Current (I_s)		
Sending Power (W_s)		
Receiving Voltage (V_R)		
Receiving Current (I_R)		
Receiving Power (W_R)		
Line Volt Drop (V_d)		

Table 5 Blank Results Table for Experiment 1

Procedure 2 - Resistive and Inductive Load

Repeat Procedure 1, but use a 50% inductive load in parallel with the resistive load (shown by the dotted lines of the connection diagram).

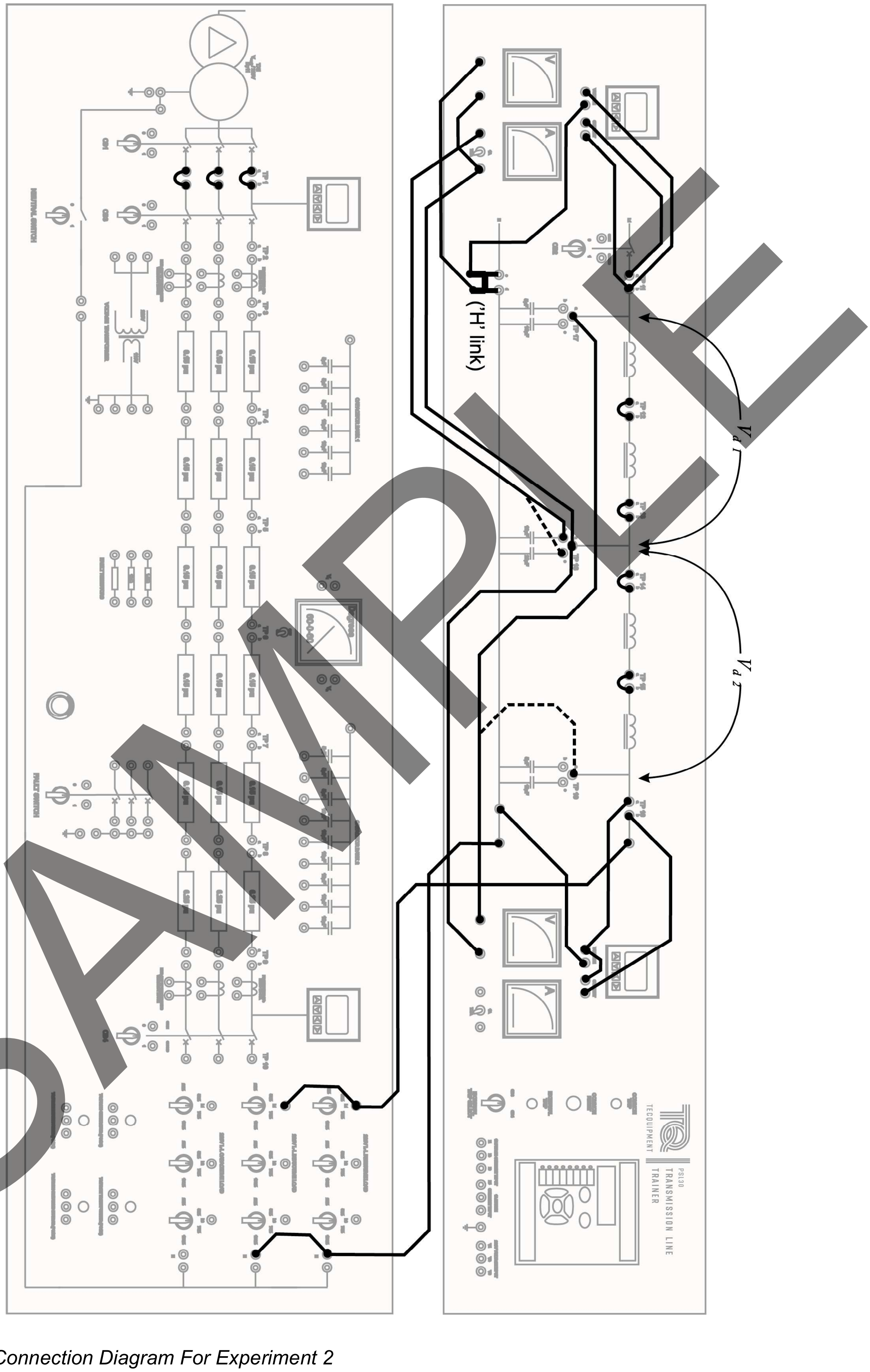

Figure 35 Connection Diagram For Experiment 2

Experiment 2: Single Phase Line - Medium or Long Line Investigation (Nominal T Method)

Aims

To find the regulation and transmission efficiency of a longer line with shunt capacitance (represented by the nominal T circuit), and to construct the relevant phasor diagram.

Notes

You use the full length of the single phase line, with all four inductors and a shunt capacitor connected half-way along the line in the T type connection.

Procedure 1 - Shunt 10 μF (50 Hz) or 8 μF (60 Hz)

1) Create a blank table of results, similar to Table 6.

2) Connect the circuit as shown in Figure 35 using all four inductors. Select a 100% resistive and 50% inductive load.

3) Shut CB1 (at the secondary of the supply transformer) and CB2 (at the ‘send’ end of the single phase line). This connects power to the line.

4) Use the right-hand analogue voltmeter to measure the voltage drop (V_{d1}) across the two inductances at the sending end, and the volt drop across the two inductances at receiving end (V_{d2}). In Figure 35, the right-hand dotted line shows which wire to move to make this connection. Use the multifunction meters to measure the sending and receiving end voltages, currents and power. You can also use these meters to show power factor, but for good practice, use equation 6 to calculate the power factor for each end of the line. The sending end voltage should remain fairly constant - determined by your local mains supply and cables.

$$\text{Power Factor } (\phi) = \frac{W}{VI} \qquad (6)$$

Voltages, Currents and Powers	Shunt 10μF 50 Hz 8 μF 60 Hz	Shunt 20μF 50 Hz 16 μF 60 Hz
Sending Voltage (V_s)		
Sending Current (I_s)		
Sending Power (W_s)		
Receiving Voltage (V_R)		
Receiving Current (I_R)		
Receiving Power (W_R)		
Line Volt Drop (V_{d1})		
Line Volt Drop (V_{d2})		
Capacitor Voltage (V_C)		
Capacitor Current (I_C)		

Table 6 Blank Results Table for Experiment 2

5) As described in Section 3, find the line regulation and efficiency.

6) Construct the phasor diagram as described in Section 3 for the medium line (with nominal T). and determine the line regulation and transmission efficiency.

Procedure 2 - Shunt 20 μF (50 Hz) or 16 μF (60 Hz)

7) Repeat procedure 1, but connect the 20 μF (or 16 μF for 60 Hz) line capacitor in place of the 10 μF (or 8 μF for 60 Hz). In Figure 35, the left-hand dotted line shows which wire to move to make this connection.

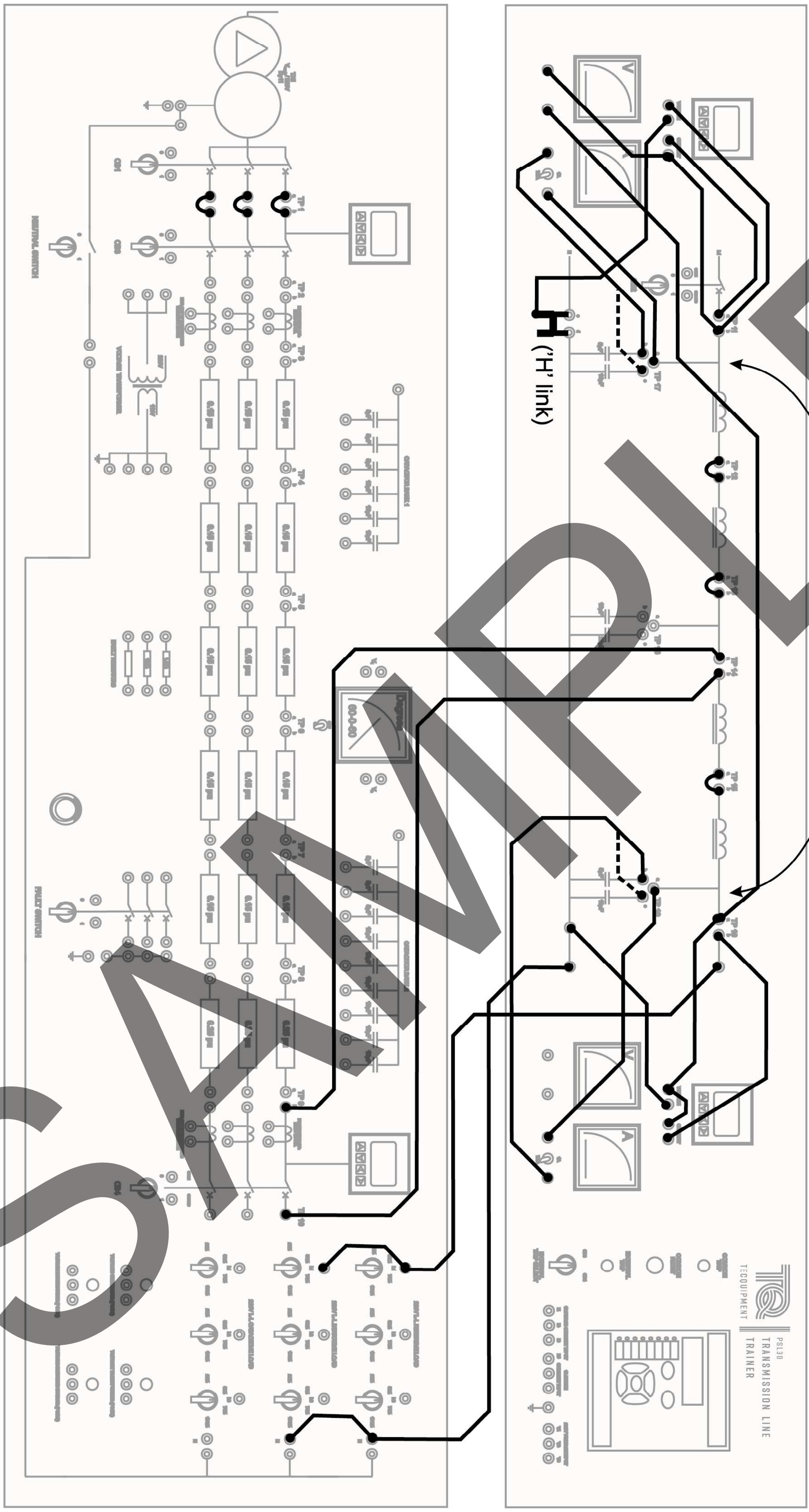

Figure 36 Connection Diagram For Experiment 3

APPENDIX 1 Typical Results

These results are typical and for reference only. Your results may be slightly different, due to tolerances in the parts of the Transmission Line Simulator.

Experiment 1: Single Phase Line - Short Line Investigation

Voltages, Currents and Powers	100% Resistive Load	100% Resistive Load + 50% Inductive Load
Sending Voltage (V_s)	125	125
Sending Current (I_s)	4.9	5
Sending Power (W_s)	589	481
Receiving Voltage (V_R)	114	102
Receiving Current (I_R)	4.9	5
Receiving Power (W_R)	565	462
Line Volt Drop (V_d)	36	36

Table 22 Results For Experiment 1 (50 Hz)

Voltages, Currents and Powers	100% Resistive Load	100% Resistive Load + 50% Inductive Load
Sending Voltage (V_s)	124.5	124.6
Sending Current (I_s)	4.95	5.06
Sending Power (W_s)	592	486
Receiving Voltage (V_R)	115.5	102.6
Receiving Current (I_R)	4.96	5.06
Receiving Power (W_R)	573	466
Line Volt Drop (V_d)	33.83	34.46

Table 23 Results For Experiment 1 (60 Hz)

Experiment 2: Single Phase Line - Medium or Long Line Investigation (Nominal T Method)

Voltages, Currents and Powers	10μF Shunt	20μF Shunt
Sending Voltage (V_s)	127	125
Sending Current (I_s)	4.1	3.9
Sending Power (W_s)	362	364
Receiving Voltage (V_R)	86	86.7
Receiving Current (I_R)	4.25	4.27
Receiving Power (W_R)	332	334
Line Volt Drop (V_{d1})	28	26
Line Volt Drop (V_{d2})	29	29
Capacitor Voltage (V_C)	108	107
Capacitor Current (I_C)	0.33	0.67

Table 24 Results For Experiment 2 (50 Hz)

Voltages, Currents and Powers	8μF Shunt	16μF Shunt
Sending Voltage (V_s)	125.4	125.4
Sending Current (I_s)	4.05	3.94
Sending Power (W_s)	358.3	369.1
Receiving Voltage (V_R)	86.2	87.6
Receiving Current (I_R)	4.24	4.31
Receiving Power (W_R)	329.5	340.5
Line Volt Drop (V_{d1})	27.9	27.3
Line Volt Drop (V_{d2})	29.3	29.8
Capacitor Voltage (V_C)	105.2	106.9
Capacitor Current (I_C)	0.31	0.64

Table 25 Results For Experiment 2 (60 Hz)