Mini National Grid Simulator

The National Grid is familiar to us all. Just look around and you will see pylons with cables strung between them. Electricity used in our homes is at about 230V. Why not just transmit it at this voltage, rather than the higher voltages ranging from 11,000V (11kV) to 400,000V (400kV), commonly used on overhead power lines?

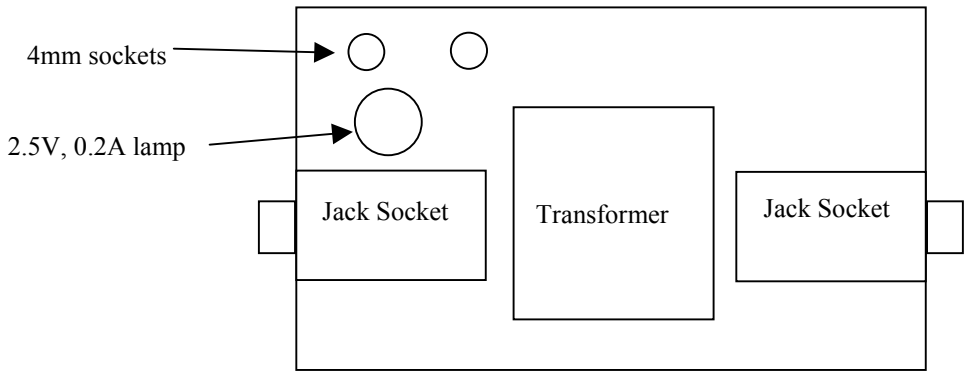
The answer is energy loss due to the heating effect of current in the power lines. This is much greater at low voltages, when the current must be high to transmit enough power. Hence the electricity suppliers transport their electricity around the country at very high voltages, in order to reduce the current, and hence the energy loss.

Typically a power station generates at 25kV. This is transformed up to 275kV/400kV, sent along the cables and then transformed down again near to where it is to be used.

It is obviously not practical, or safe, to demonstrate at these voltages so the following is a "scaled down", ultra safe version, which demonstrates the principle.

The system comprises two printed circuit boards and a dedicated set of "power lines". To ensure that it is ultra safe, it is designed to run from a 2V **ac** power source. This is readily available from most laboratory power supplies.

The two circuit boards are identical. A layout is shown below:

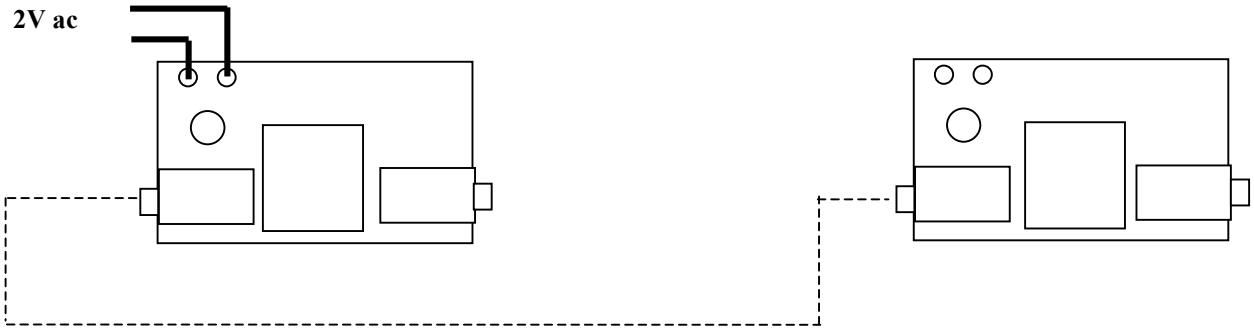


The pcb consists of a step up/step down transformer, two jack sockets, An MES lamp and two 4mm sockets. To operate the system you will need, in addition, 2 x 4mm plugged wires and a power supply capable of providing 2V **ac** at up to 0.5 amp.

The system is rated as SELV (Safety Extra-Low Voltage). This means that it is safe for pupils to handle under all operating conditions.

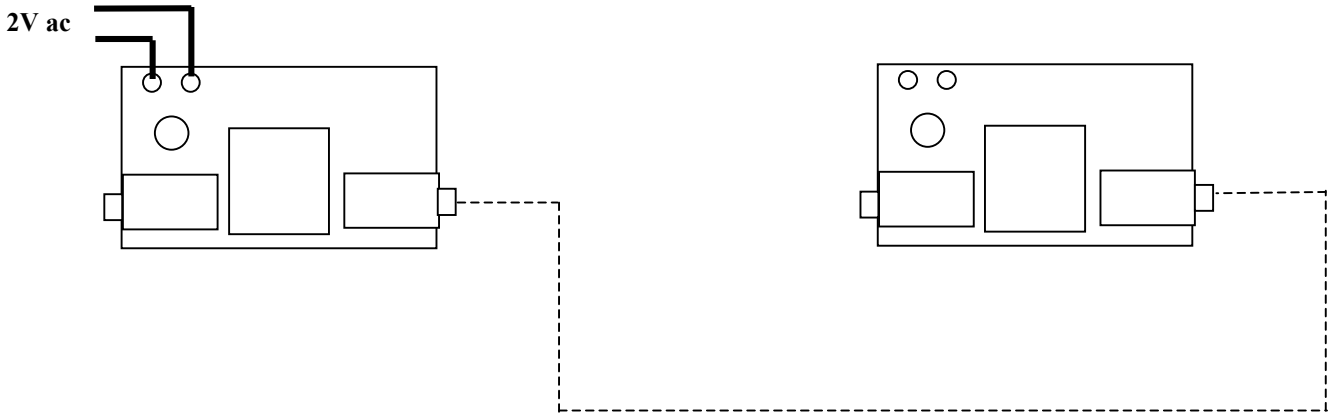
PLEASE NOTE. The system is designed to work from a 2 volt, alternating current supply. Please check that only this voltage is used, by using a voltmeter to test the voltage before connecting to the system – DO NOT RELY ON THE PRINTED VOLTAGE ON THE POWER SUPPLY. If a voltage below 2V is used the "house" lamp may not glow.

Transmitting Power at "house" voltage.



Connect a **2V ac** power supply to the sockets on the left-hand unit. Plug the jack lead between the left-hand jack sockets on each unit, as shown above. Switch on the power supply and observe the lamps. The lamp on the left-hand pcb (power station) should be bright and the one on the right-hand pcb (house) should be dim. The reason for the loss of power is that most of the energy is transformed into heat, heating up the transmission wires.

Transforming it up



With the transmission wires transferred to the right-hand side of the boards we have improved matters. Now the power station supply voltage has been transformed up by a factor of 20, giving about 40V transmission voltage. At the house end it is transformed down again to 2V for use. In our model the current flow in this system is 20 times less than before – the energy loss is proportional to the square of the current, so the energy loss is 400 times less.

The right hand lamp will be a little dimmer than the left hand one, because we still have some energy losses, but you will notice that there is a considerable improvement.

Please note that the left-hand side of one board should not be connected to the right- hand side of the other. This would cause a short circuit across the power supply.

The lamps used are **2.5V, 0.2A MES** type. Using these lamps ensures that the highest voltage developed is less than 50V.