Electricity & Magnetism

Things to do with a USB current monitor

(Ireland)

Background

USB voltage and current monitors are now quite inexpensive. They are easy to set up and can be used to demonstrate voltage-current relationships. The data generated can be the basis of further more challenging assignments.

USB devices typically draw less then 100 mA. The USB sockets on computers can usually deliver at least 100 mA; some can deliver over 500 mA.

Many low power devices, such as small lamps and motors, can be powered from computer USB sockets.

USB leads contain four wires, two for power and two for data.

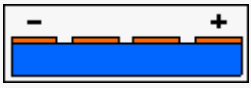
The USB terminal connections are arranged as shown in the diagram (for both the socket and the plug).
The positive terminal is 5 V ± 0.25 V; the negative terminal is the ground connection of the computer ('GND' or 0 V).

You will need...

- ✓ A computer with a USB socket
- ✓ A USB voltage and current monitor
- ✓ A USB lead
- ✓ A 5 or 6 volt lamp, or other device, as a load
- ✓ A small switch

Follow these steps

1. Cut a spare USB cable in two and remove about 2 cm of the plastic cover from the cut ends.
2. Identify the positive and negative wires; they are generally coloured red and black respectively.



3. If the wires are not coloured then use a continuity tester to identify them.
4. Cut back the two unwanted wires. Attach a small switch and a bulb holder in series with the two wires.
5. Insert a suitable bulb in the bulb holder, e.g. 6 V, 150 mA.
6. Insert the USB voltage monitor into the USB socket on the computer and connect the prepared lead. Check that the lamp and switch are working correctly.
7. Switch off the lamp and record the voltage (E); it will typically be 5.0 V. The current should show 0.0 A.
8. Then turn on the lamp and record the current (I) and the voltage (V), e.g. 0.14 A and 4.75 V. The drop in voltage is due to the 'internal resistance' (r) of the current source. Using this data the resistance (R) of the lamp can be calculated ($R = V \div I = 34\ \Omega$).
9. Note that as the current through the filament of the bulb increases, so does its temperature and resistance.

Finding the internal resistance of the source (r)

$V = R\ I\ )$

$E = (r + R)\ I$

$E = r\ I + R\ I$

$E - V = r\ I$

$r = (E\text{-}V)/I$

$= (5 - 4.75\ ) / 0.14$

$= 1.8\ \Omega$