1.4 Regulator

For some applications the smoothed voltage may be stable enough, but for other applications it may resulting in malfunction of the load circuit. To produce a constant output voltage (see Figure 2.5) the smoothed output is passed through an electronic device called a regulator. The most popular form for these solid state devices is the TO-220 package (see Figure 6).

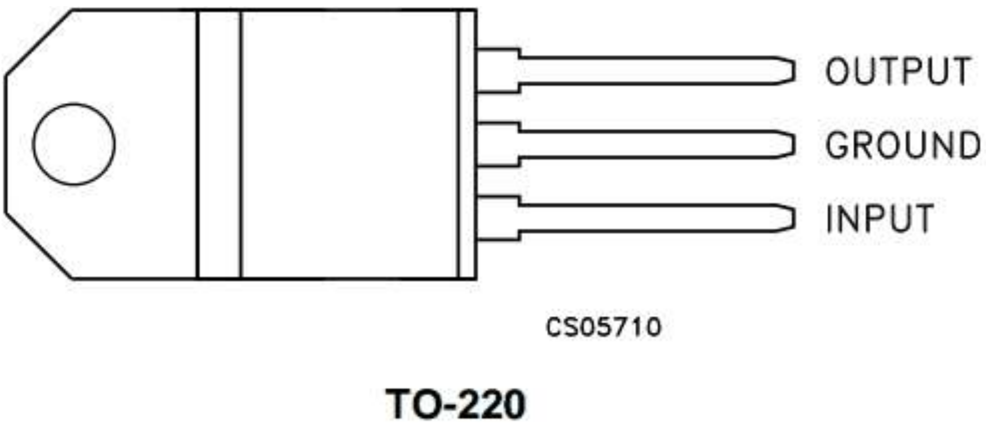

Figure 6: Regulator TO-220 package

The LM78xx produce positive voltages and LM79xx produce negative voltages. The ‘xx’ indicates the output voltage, common are 5 and 12V.

1.5 The Power Supply

Figure 7 shows a complete power supply circuit. On the left is the supply voltage (240V, 50Hz) and on the right is the load (RV1). These are not part of the power supply. In this example we have chosen a step-down transformer and then a bridge rectifier. Next are the smoothing capacitor and the regulator.

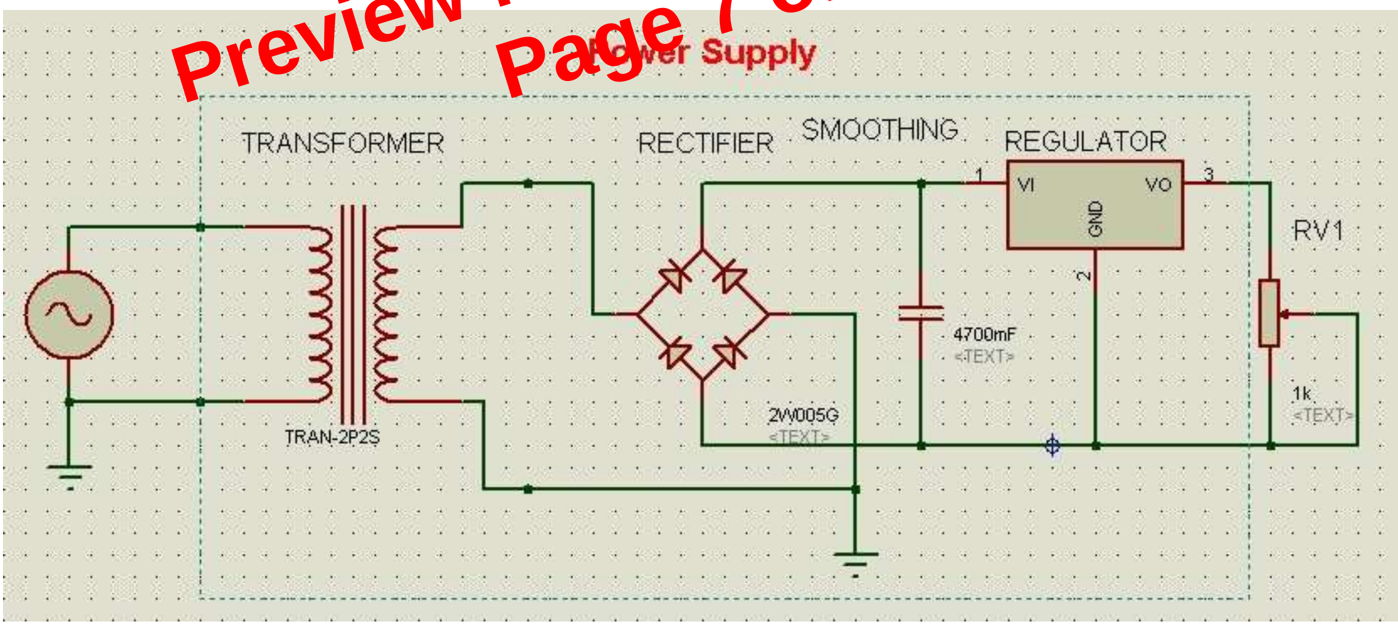

Figure 7: The complete power supply

4.8 Complete circuit - wired

Figure 11 is the Digiac 3000 experiment platform with a power supply board. (It is show without wires for clarity.) By connecting circuit #1, #8, #9 and #13 the power supply could be wired up using real components. A number of meters readings were taken at various points in the circuit (See Figure 12, Figure 13 and Figure 14). These values could (if required) be used to calculate various performance figures for the power supply.

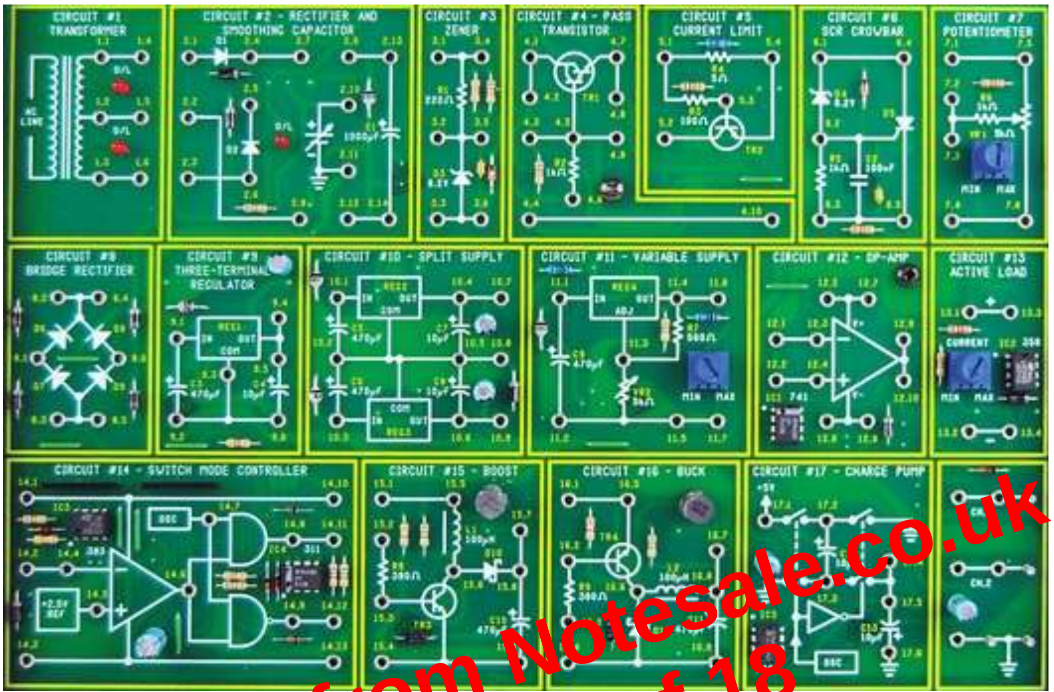

Figure 11: Wiring the circuit on a Digiac 3000 – Power supply module

Figure 12: Almost 5V output

Figure 13: Full load - 51.7mA

Figure 14: Part load - 41.7mA

6 Power Supply Analysis and Improvements (Q3c)

By comparing the power going into individual components against the power out we will identify the inefficient component.

Table 8: %Efficiency of the Transformer (calculated at full load)

$AC\ Output\ Power = V_{OUT} * I_{OUT}$ $AC\ Output\ Power = 19.9 * 1.78$ $AC\ Output\ Power = 35.422\ W$	$\%Efficiency = \frac{AC\ Output\ Power}{AC\ Input\ Power} * 100$ $\%Efficiency = \frac{35.422}{35.85} * 100$ $\%Efficiency = 98.81\%\ (2dp)$

Table 8 shows that the transformer is extremely efficient, approaching 100%.

Table 9: Efficiency of the Rectifier (calculated at full load)

$Rectifier\ Input\ Power = V_{IN} * I_{IN}$ $Rectifier\ Input\ Power = 25.9 * 0.8$ $Rectifier\ Input\ Power = 20.72\ W$ $Rectifier\ Output\ Power = V_{OUT} * I_{OUT}$ $Rectifier\ Output\ Power = 11.9 * 0.79$ $Rectifier\ Output\ Power = 9.401\ W$	$\%Efficiency = \frac{Rectifier\ Output\ Power}{Rectifier\ Input\ Power} * 100$ $\%Efficiency = \frac{9.401}{20.72} * 100$ $\%Efficiency = 45.37\%\ (2dp)$

Table 9 shows that the efficiency of the rectifier is very poor, less than 50%. Here is where most of the power is 'lost'. The rectifier is reducing an input voltage from 25.9V to 12V without altering the current significantly. The 'lost' energy is dissipated as heat.

By reducing the output value of the transformer we can reduce the voltage supplied to the regulator, and hence reduce the amount of energy converted to heat. If we lower the value too much, however, the voltage into the regulator will be too low, reducing the output voltage.

Linear regulators will only produce the rated output voltage if the input voltage is at least a specific number of volts above the rated output voltage. This is the *dropout voltage* and is specified in the data sheet for the rectifier.

$$Dropout\ Voltage\ (V_{do}) = Minimum\ Input\ Voltage - Rated\ Output\ Voltage$$

The 7812 Regulator in the power supply has a Dropout Voltage, $V_{do} = 2V$, although the minimum supply voltage is specified as 14.5V (Farnell UK Limited, 2013).