# Worksheet 7 (Tutorial)

Bargraph Driver

Some electronic devices present numerical information in the form of a bargraph. Typically there is a column of lights, and at any time the number of consecutive lights which are on, starting from the bottom, represents a numerical value. Music systems often use this scheme to show the overall volume setting, or the strength of the signal in a particular frequency range. For example, if the bargraph can represent a value between 0 and 7 (in this diagram, black represents a light being on, and white represents a light being off):


Value 3   Value 4   Value 7   Value 0
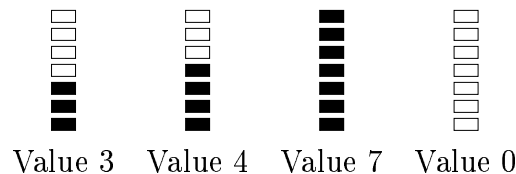
A *bargraph driver* is a circuit which inputs a binary number (for this exercise it will be a 3 or 4 bit number) and outputs $a, b, c, \ldots$ which are the values of the lights, from bottom to top. These values are 1 for on (black in the diagram) and 0 for off (white in the diagram).

1. Work out the truth table for a bargraph driver which inputs a 3 bit number xyz (i.e. x, y, z are the digits of a 3 bit binary number, from left to right) and outputs a, b, c, d, e, f, g (so a is the bottom light and g is the top light).

2. Work out a Karnaugh map for each output $a, \ldots, g$.

3. From the Karnaugh maps, work out formulae for $a, \ldots, g$. Try to work out the simplest formulae (i.e. use the largest possible rectangles).

Inverse of Bargraph Driver

Now consider the inverse problem: designing a circuit which inputs $a, \ldots, g$ and outputs x, y, z. For example, imagine that $a, \ldots, g$ are the outputs of a series of sensors at different heights in a fuel tank, and have value 1 if the sensor is submerged, 0 otherwise.
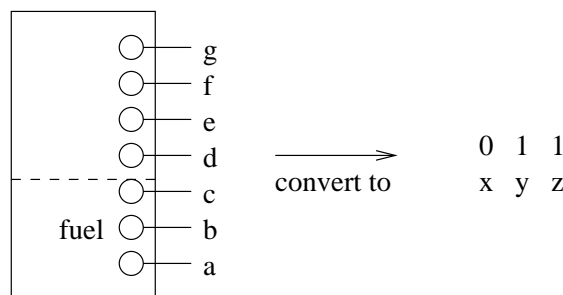
When the fuel is at a certain depth, a number of sensors will be submerged, from the bottom upwards. We want to convert the sensor values into a 3 bit binary value xyz which gives a measure of the fuel level.

5. One way of designing the circuit would be to think in terms of a 7 input truth table, and express x, y, z in sum of products form using minterms built from $a, \ldots, g$. This would lead to quite complicated formulae, which would be difficult to simplify because the Karnaugh maps would be unmanagable.

   There is a simpler way which uses adders. Work out how to do this and draw a circuit diagram.

Handing in

Hand in your design work at the end of the tutorial. Your tutor will return it with feedback at the next class.