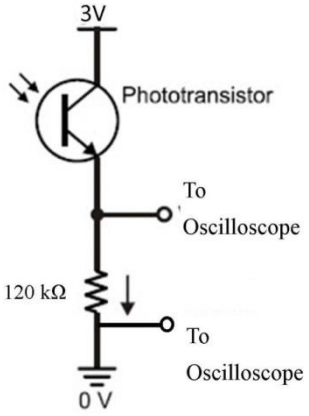
Measuring the properties of liquid crystals

Liquid crystals consist of rod like molecules which display the ordering of a solid but can still flow like a liquid. In this practical we investigate how the ordering of liquid crystals can be manipulated using an electric field.

In this practical you will:

1. Understand how the experiment works
2. Measure the switch on voltage for the display
3. Measure how the molecules align and return to their equilibrium configuration during the switching process.

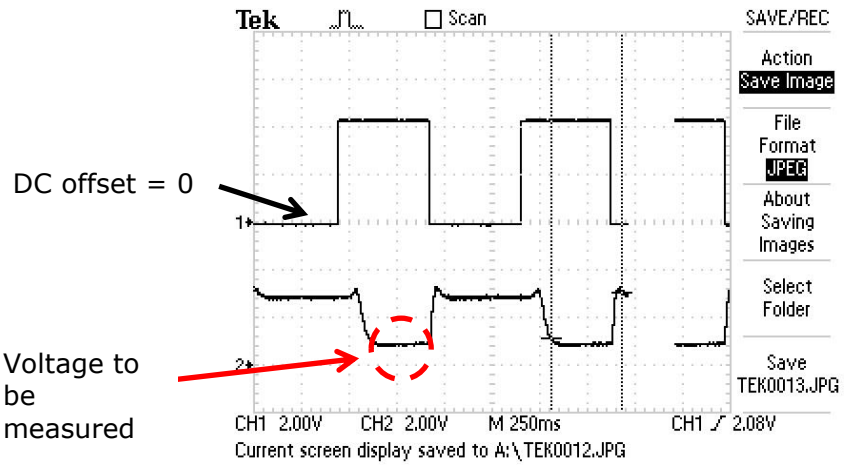
<u>The experimental setup</u>



This experiment uses a simple electrical circuit to characterise how much light is being transmitted through the LCD. In the tube is a phototransistor connected in series with a resistor. As the amount of light reaching the phototransistor varies so the voltage drop measured across the resistor also changes. The signal generator is used to switch the LCD on and off, which changes how much light reaches the phototransistor.

Look at the oscilloscope. There are two traces.

1. The wave form of the signal generator which switches the LCD from one state to the other (If you look at the LCD you should see it blinking).
2. The other is the measured light intensity passing through the LCD.



In all these experiments every time you adjust the amplitude on the signal generator you must also adjust the DC offset.

a. On the signal generator gently increase the amplitude and watch the Ch1 trace on the oscilloscope.

b. Now on the signal generator alter the DC offset until the bottom of the square wave shown on Ch1 of the oscilloscope is at 0 (See figure above). Zero is where the little 1 is on the left hand side of the screen.

<u>Measuring the switch on voltage of the LCD</u>

1. On the signal generator set the amplitude to 7V and then looking at the oscilloscope **adjust the DC offset to zero.**
2. Press "single seq"

The signals should now be paused. Adjust the big knob highlighted in green on the oscilloscope diagram to move the cursor (This is a vertical black line). **If you don't see this ask for help.**

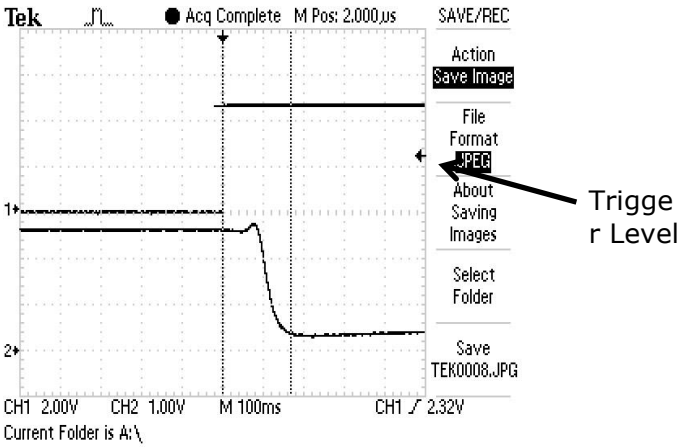
3. Look at the figure above. Position the cursor at the lowest point of the wave on Ch2 as indicated in the figure above by the red circle.
4. Read the voltage measurement from the highlighted cursor

5. On the oscilloscope press Run/Stop once.
6. On the signal generator gradually decrease the amplitude repeating steps 2, 3 & 4 above, taking data points at appropriate intervals. Each time you decrease the voltage have a look at the LCD display. **Remember you always need to adjust the DC offset every time you change the amplitude.**
7. Make a table recording the voltage on the signal generator (x data) and the transmitted light voltage from the oscilloscope Ch2 (y data). Plot this graph on the paper provided.

Your graph should reveal a change around a particular voltage corresponding to the LCD changing colour. This is the switch on voltage of the LCD. The change with applied voltage is however not instantaneous. What do you think might be happening to the molecules to cause this?

<u>Measuring the switch on and off time of the LCD</u>

1. On the signal generator set the voltage to 5V and adjust DC offset.
2. On the signal generator set the frequency to 0.3Hz
3. On the oscilloscope press "trigger menu"
4. Select source = "Ch1" and Slope = "rising" (These buttons are next to the screen). Adjust the time scale to around 50ms.
5. Press "single seq"



Hopefully you should see something like the graph above. How long does it take the liquid crystal molecules to align in the electric field?

6. How long does it take for the molecules to rearrange?
7. Repeat the steps above and select "fall" instead of "rise".
8. How long does it take the molecules to reform the twisted helix structure? Which process is faster and why?