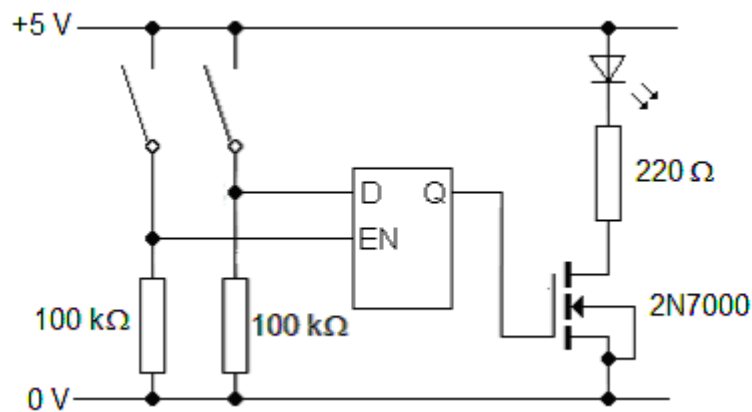


Latches

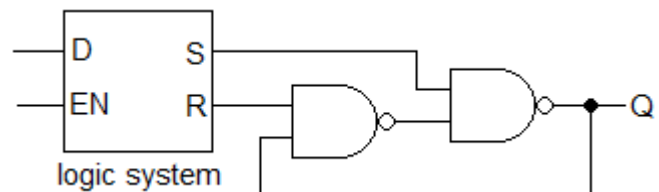
You are going to investigate the behaviour of one of the latches in a 4042 i.c. Then you will design, build and test one made from just NAND gates.

- 1 Assemble the circuit shown below. You should already have the input and output sub-systems on your breadboard. Ensure that the P terminal of the i.c. is pulled high, so that the EN input is active-high.



- 1 Make EN low. Verify that the signal at D has no effect on the state of Q. Then make EN high. Verify that the signal at D is immediately copied to Q.

- 2 Here is a circuit for a latch. The NAND gate bistable has active-low inputs. Complete the truth table below for the logic system.



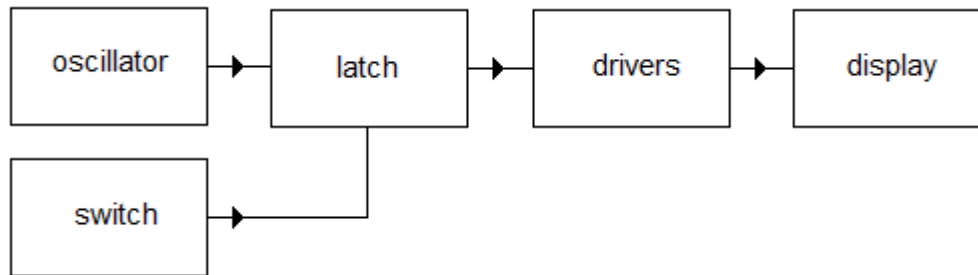
EN	D	S	R	state of latch
0	0			frozen
0	1			frozen
1	0			reset
1	1			set

- 3 Use the truth table to write down Boolean algebra expressions for S and R in terms of EN and D. Show how they can be implemented with just NAND gates.
- 4 Replace the 4042 latch i.c. with its NAND gate equivalent. Use the switches and LED to verify that it behaves as required.

Random numbers

You are going to design, assemble and test a system for generating random numbers.

- 1 The system shown below selects a 1 or a 0 at random each time the switch is released. Start off by assembling an oscillator with a frequency of about 2 kHz. Use an oscilloscope to verify its operation.



- 2 Then add the latch and switch, such that pressing the switch makes the latch transparent. Use the oscilloscope to verify that the output of the latch freezes high or low at random when the switch is released.
- 3 Add a pair of MOSFET drivers, 220 Ω resistors and LEDs to display the output. Use a red LED for 1 and a green LED for 0.
- 4 Press and release the switch 100 times, recording the result each time. Is the result really random?
- 5 Assemble the system shown below. Think carefully about each oscillator's frequency.

