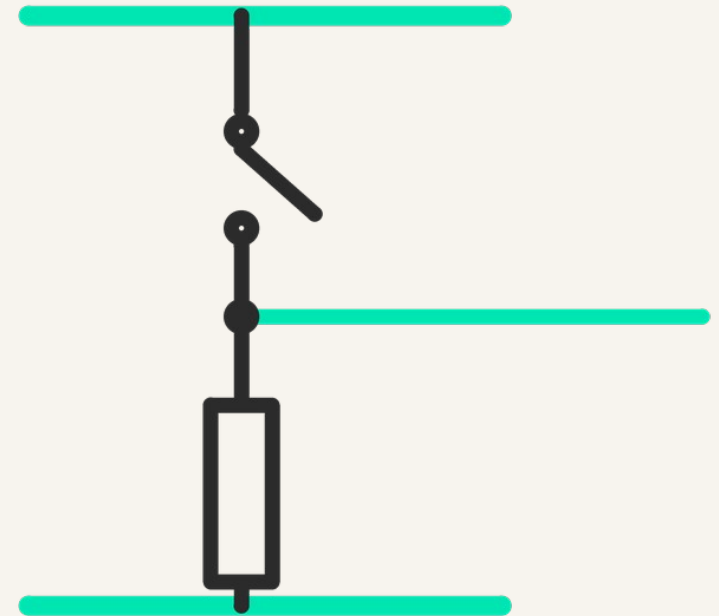


Switches and the Logic Probe

An input connected to nothing is not a logic 0. It is a fault waiting to happen.

National 5 Practical Electronics



LEARNING INTENTION

To wire a switch so the input never floats, and to test any point in a circuit with a logic probe.

Daily Review

SHOW ME BOARDS

- 1 Which pin is 0 V on a 14-pin chip?
- 2 Which pin is +5 V?
- 3 What do you do with a spare gate's input pins?
- 4 How many AND gates are inside a 7408?
- 5 What happens to a 74HC input left unconnected?

By the end of this lesson...

- 1 I can explain why a floating input is unreliable.
- 2 I can draw a switch with a pull-down resistor.
- 3 I can state where the red and black leads of a logic probe connect.
- 4 I can describe how a probe shows logic 1, logic 0 and a pulse.

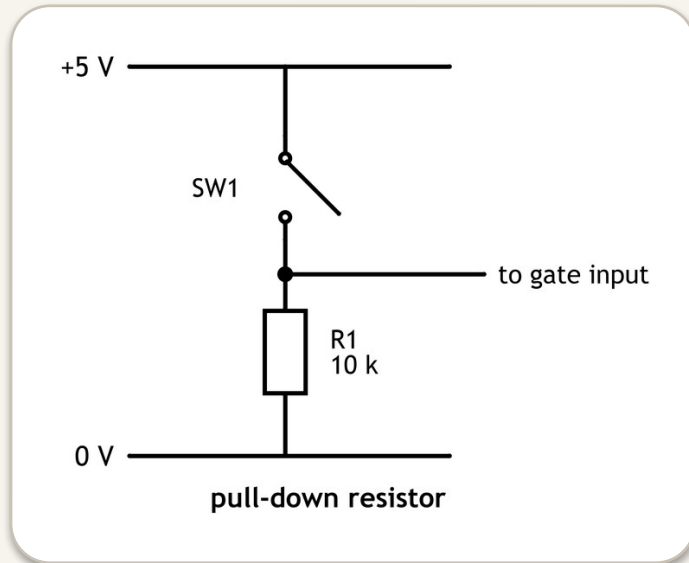
The floating input problem

Booklet section 7.

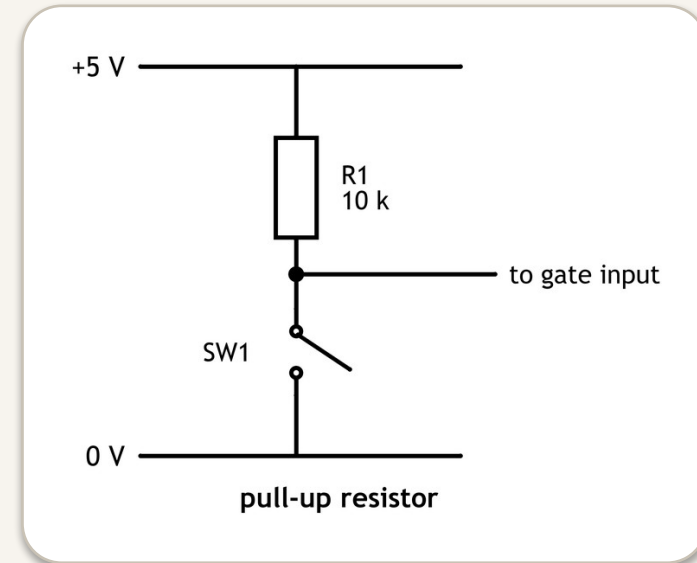
- A plain on/off (SPST) switch connects the input to +5 V when closed.
- Open it, and the input is connected to nothing at all.
- A floating 74HC input drifts and picks up noise.
- The gate then switches at random — and can get hot.

Two ways to fix it

A resistor that holds the input when the switch is open.



PULL-DOWN



PULL-UP

- Pull-down: switch to +5 V, resistor to 0 V. Open reads 0.
- Pull-up: switch to 0 V, resistor to +5 V. Open reads 1.

Which one do I use?

Booklet section 7 – 10 k is a good value for either.

Operating the switch should give...	Use this
logic 1 – the usual arrangement	a PULL-DOWN resistor
logic 0	a PULL-UP resistor
either, driven in both positions	an SPDT changeover switch
never	a 74HC input connected to nothing

Show Me — Open or closed?

SHOW ME BOARDS

- 1 A switch with a pull-down is OPEN. What logic state is the input?
- 2 The same switch is CLOSED. What logic state now?
- 3 A switch with a pull-up is OPEN. What logic state?
- 4 You want pressing the switch to give logic 1. Which resistor?
- 5 What value would you fit?

Open or closed?

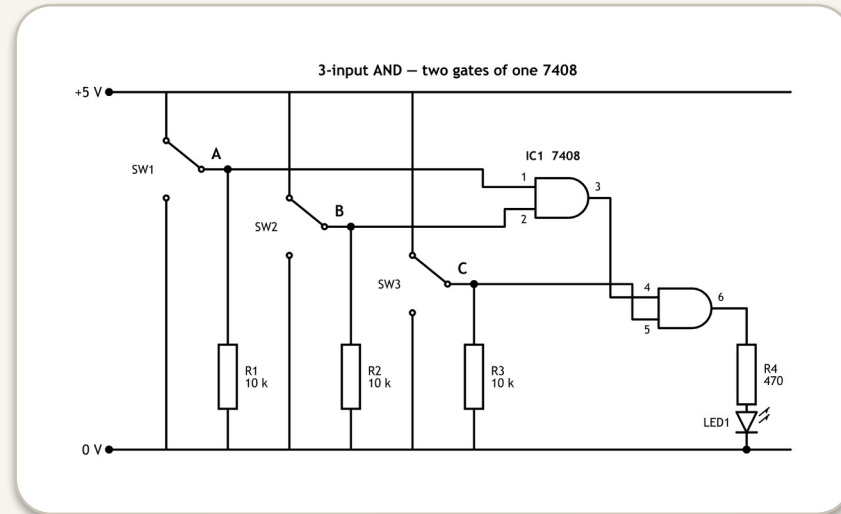
SHOW ME BOARDS

EXTRA PRACTICE

- 1 A switch with a pull-up is CLOSED. What logic state is the input?
- 2 You want pressing the switch to give logic 0. Which resistor?
- 3 Which rail does a pull-down resistor connect to?
- 4 Which rail does the switch connect to in a pull-down circuit?
- 5 Where is the gate input taken from?

The SPDT switch – and why the pull-down stays

This is what you will build in section 10.

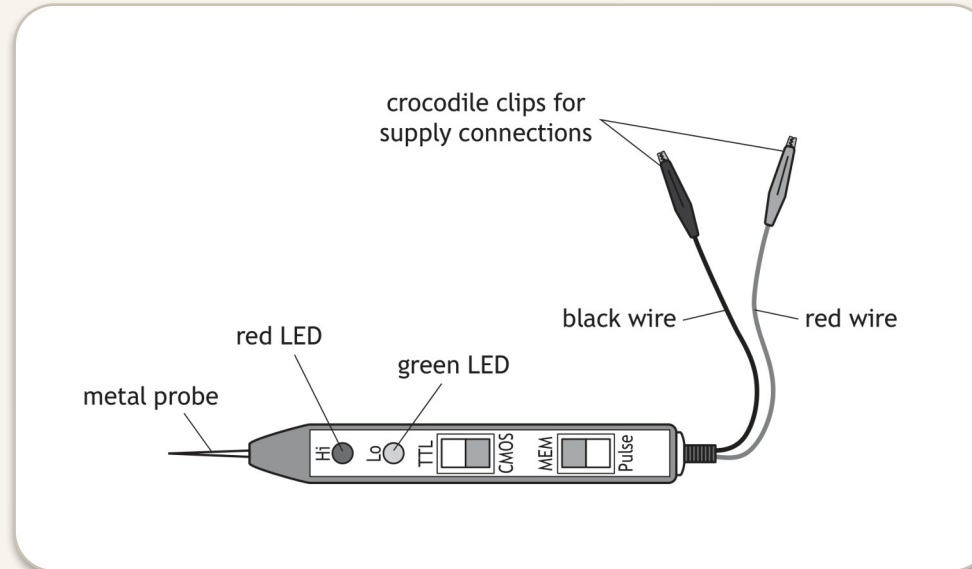


Wiper to the gate input, one contact to +5 V, the other to 0 V – and R1 to R3 kept.

- An SPDT breaks one contact before it makes the other.
- Mid-throw the input floats – the one thing 74HC must not do.
- The 10 k pull-down holds it at logic 0 through that gap.

The logic probe

Booklet section 8. Use a probe, not a multimeter, on logic circuits.



A logic probe. From the SQA National 5 question paper 2025.

- It powers itself from the circuit under test.
- Set the switch to TTL for 74 series chips, and Pulse to catch a change.

Connecting the probe

Say it exactly this way – the 2025 report found most answers vague.

Lead	Connect it to
the red wire	the +V supply rail of the circuit under test
the black wire	the 0 V rail of the circuit under test
the metal tip	the point you are testing – this is what you move

Reading the probe

What you see	What it means
red LED (Hi) on	the point being touched is at logic 1
green LED (Lo) on	the point being touched is at logic 0
an LED flashing	the point is pulsing – the level is changing
neither LED on	the point is floating, or the probe is not powered

Show Me — What does the probe show?

SHOW ME BOARDS

- 1 Where does the red wire connect?
- 2 Where does the black wire connect?
- 3 You touch pin 14. Which LED lights?
- 4 You touch pin 7. Which LED lights, and why?
- 5 Neither LED lights. Give two possible reasons.

What does the probe show?

SHOW ME BOARDS

EXTRA PRACTICE

- 1 The red Hi LED is on. What is the logic state?
- 2 An LED is flashing. What is happening at that point?
- 3 Which setting do you use for 74 series chips?
- 4 Describe how a logic 1 is detected.
- 5 Why use a probe rather than a multimeter here?

Watch Out

All three cost marks in the 2025 paper.

THE MISTAKE

- Touch the red lead onto the point being tested.
- Describing pin 7 as 'ground'.
- An SPDT makes the pull-down redundant.

THE CORRECT ANSWER

- The red lead goes to +V. The metal TIP touches the point.
- Say pin 7 is CONNECTED to ground (0 V).
- Keep it. Mid-throw the input would float.

Checkpoint

SHOW ME BOARDS

- 1 Explain why a floating input is unreliable on a 74HC chip.
- 2 Describe how you would wire a switch so that pressing it gives logic 1.
- 3 The probe is on pin 7 and the green LED is on. Explain what that shows.

Exam Practice

Logic-probe questions. Bring the paper; nothing is reproduced here.

Paper	Question	Marks	What it asks
N5 2025	7 (a) (i)	1	Where the red and black wires connect
N5 2025	7 (a) (ii)	2	Describe how a logic 1 is detected
N5 2025	7 (b) (ii)	1	Why the probe flashes green at pin 7

LOOKING AHEAD

Breadboard prototyping

Next: a real chip, real switches and real wire — and a way to find the fault when it does not work.

Plenary

SHOW ME BOARDS

- 1 Why must a 74HC input never be left floating?
- 2 Which resistor do you use so that pressing gives logic 1?
- 3 What value of resistor?
- 4 Where does the probe's red wire go?
- 5 Green LED on. What logic state?

Plenary

SHOW ME BOARDS

EXTRA PRACTICE

- 1 What does a floating input do on a 74HC chip?
- 2 Which resistor do you use so that pressing gives logic 0?
- 3 Which rail does a pull-up resistor connect to?
- 4 Where does the probe's black wire go?
- 5 Red LED on. What logic state?

Extension

- 1 Why does an SPDT still need a pull-down on a 74HC chip but not on TTL?
- 2 The teacher booklet says 100 k works as well as 10 k. Why?
- 3 A probe shows nothing anywhere on a board. What would you check first?

Extension

EXTRA PRACTICE

- 1 Why does the probe take its power from the circuit under test?
- 2 What would a multimeter show at a point that is pulsing?
- 3 A gate's behaviour changes when you touch the board. Explain.