

EN / LEARNING SERIES

Quantum Circuits Field Guide

Gates, circuits and reproducible experiments

SCIENCE · TECHNOLOGY · TALENT · FUTURE

Independent educational publication. Concepts are presented for learning and should be validated against primary technical sources for research, engineering or security decisions.

1. Reading a circuit

A quantum circuit is read from left to right. Horizontal wires represent qubits; symbols on the wires represent gates, measurements or barriers.

Circuit depth describes how many sequential layers are required. On noisy hardware, shorter circuits are often more reliable.

KEY TERMS

wire • gate • measurement • depth

2. Essential gates

X swaps the basis states 0 and 1. Z changes the phase of the 1 component. H creates or recombines equal superpositions. Rotation gates allow continuous control.

Controlled gates connect the operation on one qubit to the state of another and are used to create entanglement.

KEY TERMS

X • Z • H • CNOT • rotation

3. From simulator to hardware

First calculate the ideal result. Run a noiseless simulation, then a noisy model, and only then use a real processor.

Report provider, backend, date, calibration data, transpilation settings, shots and raw counts. Without these details the experiment is difficult to reproduce.

KEY TERMS

ideal baseline • noise model • transpilation • shots

4. Mini experiment

Prepare $|0\rangle$, apply H and measure 1,000 times. Expect an approximately even distribution. Add a second H before measurement and expect a return to $|0\rangle$ in an ideal circuit.

This simple comparison demonstrates that superposition is not merely classical randomness: the phase information created by the first H can be recombined by the second.

KEY TERMS

hypothesis • circuit • result • interpretation

Suggested practice

Use the interactive modules at quantumserbia.com to test the ideas in this guide. Write down a prediction before every simulation, then compare the result and explain any difference.