

4.4 Measurement

A final element used in quantum circuits, almost implicitly sometimes, is measurement. In our circuits, we shall denote a projective measurement in the computational basis using a ‘meter’ symbol.

It is conventional to not use any special symbols to denote more general measurements, because they can always be represented by unitary transforms with ancilla qubits followed by projective measurements.

Two important principles:

Principle of deferred measurement: Measurements can always be moved from an intermediate stage of a quantum circuit to the end of the circuit; if the measurement results are used at any stage of the circuit then the classically controlled operations can be replaced by conditional quantum operations.

Principle of implicit measurement: Without loss of generality, any unmeasured quantum wires (qubits which are not measured) at the end of a quantum circuit may be assumed to be measured.

1 – Often, quantum measurements are performed as an intermediate step in a quantum circuit, and the measurement results are used to conditionally control subsequent quantum gates. However, such measurements can *always* be moved to the end of the circuit.

2 – Imagine you have a quantum circuit containing just two qubits, and only the first qubit is measured at the end of the circuit. Then the measurement statistics observed at this time are completely determined by the reduced density matrix of the first qubit. The measurement of the second qubit does not change the result of the measurement of the first qubit.