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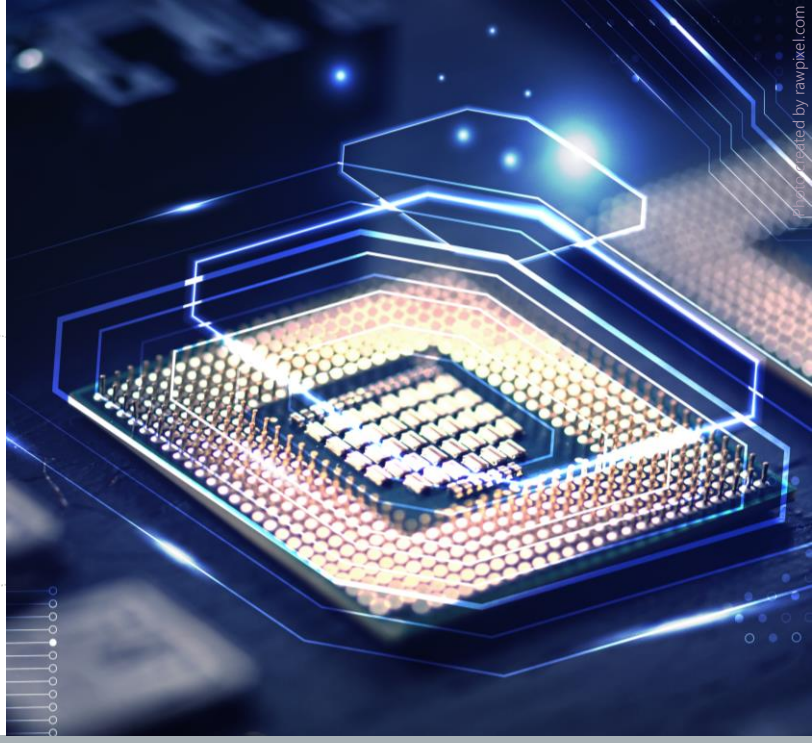
Design of a quantum based single-bit full-adder with greater energy efficiency than currently existing transistor-based technologies. The encoding of information in only a few electrons trapped inside a semiconductor system of three quantum dots allows the execution of a full-adder through coherent quantum dynamics, which are inherently energy conservative.



Tech offer | Full-adder based on coherent quantum dynamics for energy efficient computing

Current semiconductor technology is reaching its limits, with further miniaturization incurring heavy thermal loads due to the dissipative nature of transistor-based devices, which will subsequently lead the performance to plateau. At the same time, over the past decades, the research and development of quantum computation has grown exponentially.

The proposed technology is a spin-off from this research, where the main purpose is, instead, to exploit a binary encoding of logic in low-energy quantum states to do classical computation with reduced energy cost. Related technologies (e.g. Quantum Dot Cellular Automata) have been proposed for energy efficient computation, however their experimental development has been hindered by the complexity of the devices, which require dozens of quantum dots for even the simplest operations. The present model uses a triple quantum dot system to execute the addition of two bits through a series of Fredkin gates, which swap the state of two bits conditional on a third bit. The sum of two bits is a fundamental operation in any computer's Arithmetic and Logic Unit (ALU). The dynamics of the Fredkin gate are implemented through the quantum coherent dynamics of electrons tunneling between the quantum dots, which are inherently conservative.

APPLICATIONS

High-Performance Computing (HPC) Systems

Very Large Scale Integration (VLSI) Circuits

Large-scale data centers

Reversible computing

BENEFITS

Significantly improved energy efficiency of future computing technologies, specially in the realm of HPC systems. Simulations of the proposed full-adder highlight a potential energetic cost in the milli electron-volt ranges several orders of magnitude below current transistor-based full-adders.

Compatibility with industrial standards in semiconductor fabrication: the usage of semiconductor quantum dots is a great advantage given their compatibility with the currently advanced industrial standards.

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INTELLECTUAL PROPERTY

Patent application filed in Portugal (PT116602)
International Patent Application (PCT/PT2021/050022) - ABANDONED

TECHNOLOGY ID

PI-1020

SCIENTIFIC PUBLICATIONS

J. P. Moutinho, M. Pezzutto, F. Silva, S. Franceschi, S. Bose, A T. Costa and Y. Omar, "Quantum coherence for energetic advantage in a charge based full-adder", in preparation.

INVENTORS

Researchers from:
– Instituto de Telecomunicações (Portugal)
– Instituto Superior Técnico (Portugal)

DEVELOPMENT STAGE

TRL 2
Theoretical model based on a realistic, experimentally verified triple quantum dot system. Simulations show the full-adder can be operated with a wide range of realistic parameters, allowing flexibility in the implementation. Given that other triple quantum dot systems have been demonstrated in a lab environment for other purposes, a first proof-of-concept experiment for this technology to achieve TRL 3 is expected to be straightforward.

KEYWORDS

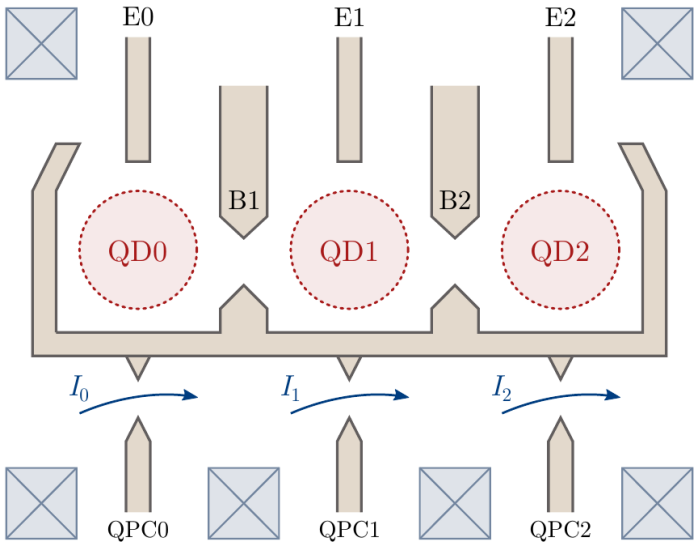
QUANTUM TECHNOLOGIES
REVERSIBLE COMPUTING
VLSI CIRCUITS
HPC SYSTEMS

COMMERCIAL OFFERING

- Licensing or assignment agreement
- Joint further theoretical and experimental developments

TARGET MARKET

Instituto de Telecomunicações seeks partners within industry or R&D, working on chip manufacturing, semiconductor technologies or quantum computing.



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