FormFactor™

Echo-5Q

## Lab Scale Quantum Computer Project with Tabor Electronics and QuantWare

The Echo-5Q project was a collaboration between FormFactor Inc., Tabor Electronics LLC, and QuantWare to combine three industry-leading technologies in cryogenics, microwave electronics, and quantum fabrication processes.

The goal is to build a system that lowers the barriers of entry for any organization to become involved in the quantum computing revolution. The Echo-5Q is a tool designed for scientists and engineers to push the bounds of technology and to cultivate the next generation of the quantum workforce.

FormFactor's HPD LF-600 featuring the Aspect DR core and Frostbyte™ software offers high cooling powers at ultra-low temperatures and a stable light-tight environment. Tabor's Proteus, an FPGA-based Direct to Microwave Digital Synthesis System, offers excellent phase noise and spurious performance without the need for cumbersome up/down converting units. Quantware's Soprano QPU and Crescendo-S TWPA are manufactured using state-of-the-art fabrication processes enabling excellent coherence times and readout fidelities.

FormFactor HPD LF-600 Cryogen Free Dilution Refrigerator
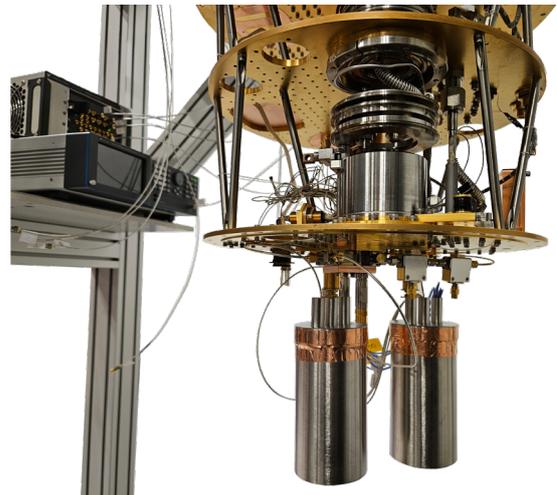
Tabor Electronics Proteus series direct-to-microwave quantum control electronics.

Quantware Soprano 5-Qubit QPU and the Crescendo-S traveling-wave parametric amplifer.

TQS
TABOR QUANTUM SOLUTIONS

QW QUANTWARE

System Includes

Cryogenic system

- **HPD LF-600** Cryogen-free Dilution Refrigerator
- RF and DC cables and components for control, readout, and flux bias and signal conditioning
- Magnet shield, HEMTs, circulators, and IR/RF filters

Quantum processor

- Quantware **Soprano** 5 Qubit QPU
- Quantware **Crescendo-S** Traveling-Wave Parametric Amplifier

Control electronics

- Tabor **Proteus**, a FPGA-based Direct to Microwave Digital Synthesis System
- Complete Qubit Characterization and Coherence Suite (Spectroscopy, Rabi, T_1, T_2, etc.) included

Performance Specifications

Property	Reference*
T_1	108 μs
$T_2{}^*$	103 μs
T_2e	120 μs
Single Qubit Gate Fidelity	99.95%
Two Qubit Gate Fidelity	99.7%
Read Out Fidelity	97.5%
Single qubit gate duration	40 ns

* As measured on reference systems at FormFactor and Quantware

Rabi Oscillation

Ramsey Interferometry

Energy Relaxation

Hahn Echo

FormFactor™