

# Superconducting Bosonic Qubits. Controlled.

Superconducting bosonic qubits are a leading platform for demonstrating quantum error correction in a hardware-efficient architecture. The Zurich Instruments Quantum Computing Control System (QCCS) provides a compact and

scalable solution with key features that benefit the control and measurement of bosonic qubits from basic memory mode characterization and calibration, to Wigner function tomography and two-qubit gate operations.

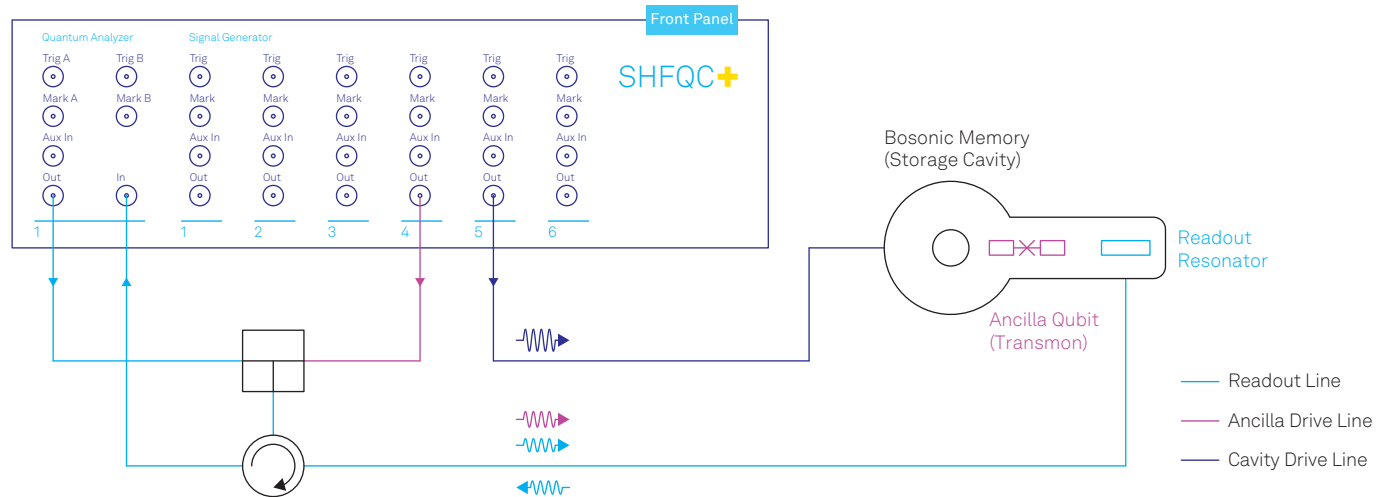


Figure 1. Typical setup of a Bosonic memory qubit coupled to a transmon ancilla qubit using an SHFQC+.

## Your Benefits

- Out-of-the-box stable synchronization between all output and input channels for phase sensitive qubit operations and readouts
- Seamless path toward scaling up with the PQSC and QHub
- Built-in upconversion to generate microwave frequencies for all mechanisms such as the two-photon dissipation or longitudinal coupling
- Fast characterization of the memory and buffer mode thanks to parallel spectroscopy and multiplexed readout
- Efficient active reset and other feedback capabilities thanks to low latency within or between instruments
- Fast integration into your setup with the LabOne Q software framework

## Your Application Resources

- Blog posts: OpenQASM circuits, synchronization over 52 meters, hands-on qubit characterization
- Code examples: standard characterization measurements in LabOne Q, measurement feedback (active reset)

## Wigner Tomography Made Easy

- Memory-efficient waveform programming minimizes memory overflow concerns for the control of long-lived memory modes
- Hardware and software logic to ensure accurate timing and phase coherence of signals across multiple control and readout channels with ease
- Low noise, ultra-low phase drift and temperature-stable microwave analog front end ensure repeatable universal control across long experiment sessions
- Output simulator and pulse sheet viewer to visualize alignment between marker outputs, microwave, RF, and baseband pulses

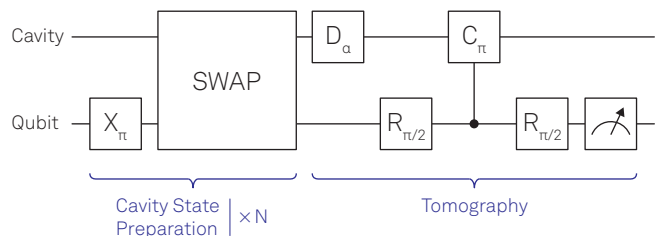
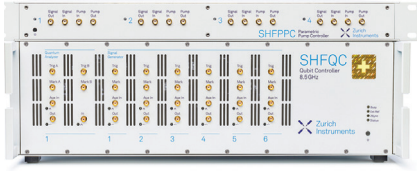


Figure 2. Example circuit diagram for Wigner Tomography of  $|N\rangle$  Fock state. The gates are an unselective  $180^\circ$  rotation about the x-axis ( $X_\pi$ ), an unselective cavity displacement ( $D_\alpha$ ), selective  $90^\circ$  qubit rotations ( $R_{\pi/2}$ ), and an entangling conditional phase gate of  $180^\circ$  ( $C_\pi$ ).

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## Product Highlights



### SHFQC+ Qubit Controller

The SHFQC+ integrates high-frequency control, measurement, and processing in one instrument. Combine the SHFQC+ with an [SHFPPC Parametric Pump Controller](#) for high-fidelity readout at the quantum limit when using Josephson parametric amplifiers.



### HDAWG Arbitrary Waveform Generator

HDAWG delivers low-frequency control generating flux pulses for frequency tuning of the ATs or couplers. Thanks to the HDAWG-PC option, it can pre-compensate for distortion on the flux lines



### PQSC Quantum System Controller

The PQSC integrates hardware and software to precisely time the control and measurement, enabling scalable, synchronized operation, real-time feedback ( $< 550\text{ns}$ ) including active reset, and error correction across multiple instruments (448 channels).



All instruments are controlled by [LabOne Q](#), an open-source Python-based software framework offering both high- and low-level access. Achieve results quickly with extensive code examples, documentation, and support.

## Meet Our Quantum Technology Experts

Every member of our Quantum Technology team has a background in advanced scientific research, including quantum error correction, quantum sensing, quantum computing, and theory of quantum algorithms.



## Our Customers' Accomplishments

- McMahon Lab (Cornell): Microwave signal processing using an analog quantum reservoir computer, [Nat. Comm.](#) **15**, 7490 (2024)
- Yu Group (SUSTech): Quantum-enhanced metrology with large Fock states, [Nat. Physics.](#) **20**, 1874 (2024)
- Quantum Device Lab (ETH Zurich): Realizing repeated quantum error correction in a distance-three surface code (using transmons), [Nature](#) **605**, 669–674 (2022)
- Filipp Group (Technical Univ. of Munich and the Walther-Meißner-Institute): Efficient decoupling of a nonlinear qubit mode from its environment (using transmons), [Phys. Rev. X](#) **14**, 041007 (2024)