

Utilization of the ADQ214 digitizer in measurement setup

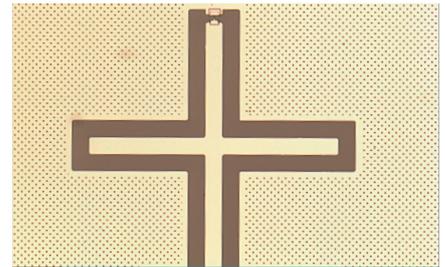
Seamless integration between different types of utilization areas

The qubits are loaded and operated in a dilution cryogenic-free refrigerator, with a cascade of amplifiers, IQ mixers, low pass filters to perform analogue manipulation of the weak photon signal, boosting it to ≈ 2.2 V while maintaining a good signal-to-noise ratio.

Since there are no robust single photon detectors in the microwave regime (which could measure the photon number ($a^\dagger a$) in the line) the small-amplitude electromagnetic fields are detected by measuring the voltage of their two quadrature's (outputted by the IQ mixers) on the two channels of an ADQ214 digitizer (which acts like a linear detector measuring the voltage ($a + a^\dagger$) in the line). These two quadrature's can deliver full information about the state of the qubit allowing for full state reconstruction, time-resolved emission profile and evaluation of the $g(1)(\tau)$ and $g(2)(\tau)$ correlation functions for demonstration of coherent single photon preparation.

The 400MHz sampling rate of the ADQ214 digitizer allows resolution of dynamics occurring in the order of news - the characteristic time for our GHz-energy qubits. The industry standard SMA inputs allow for seamless integration with the rest of the microwave components, while the external reference and triggers ensure synchronization with qubit operation protocols.

The correlation measurements being performed are resource intensive due to the relative weakness of the single photon signals and undergo post-processing on a GPU that matches the fast data transfer and acquisition through the National Instruments PXIe crate that the digitizer is slotted into. The flexible C++ interface allows customization of readout for different types of measurements. Our customer was utilizing two ADQ214 digitizers to perform measurements with a beam-splitter, requiring $[2 \text{ quadrature's}] \times [2 \text{ arms of beam splitter}] = 4$ quadrature channels by simple extension of the current hardware and software setup.



+ Quantum Technology by RHUL

Highlights

- + The ADQ214 worked seamlessly between different utilization areas.