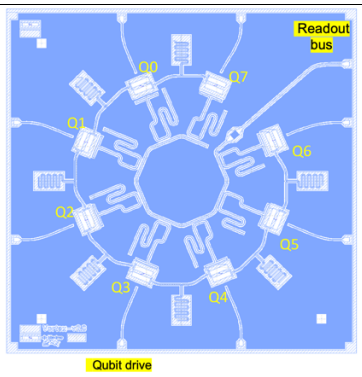
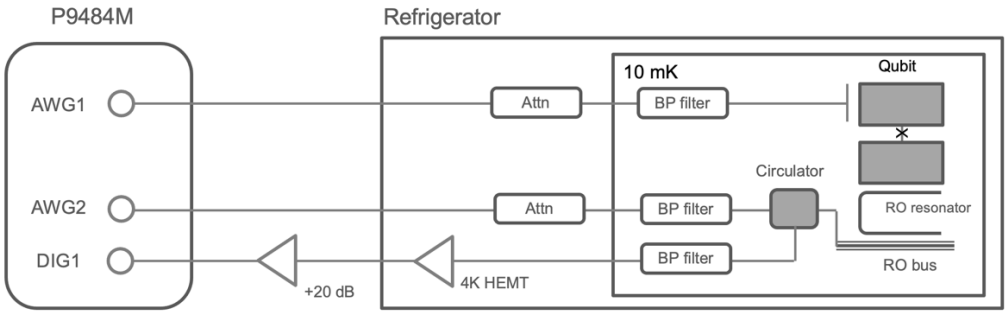
All-digital characterization of superconducting qubits

By Bleximo Corp. and Tabor Electronics

In this application note, we provide a brief introduction to a compact PXI-based Arbitrary Waveform Generator/Transceiver platform used to characterize superconducting qubits. We show all-digital control and readout of a single fixed-frequency transmon qubit coupled to its two neighbors in an 8-qubit processor. Qubit's coherence did not change from the values measured with a "reference" setup utilizing traditional I/Q up- and down- conversion built from high-end stand-alone oscillators, AWG, digitizer, mixers, and other devices.

Control module **Tabor Electronics Proteus P9484M**	Superconducting processor **Bleximo Vortex 8TQ**
	
• Two or four channels 9GS/s 16-bit AWG configurations • Integrated digital up-converter to RF frequencies • One or two 8GHz Bandwidth, 5.4GS/s 12-bit digitizer option • Up to 16GS waveform memory with the ability to simultaneously generate and download waveforms • Real time data streaming directly to the FPGA for continuous and infinite waveform generation • PXI Express platform; High speed PCIe GEN3x8 lanes communication interface	• 2D 10mm x 10mm chip 8 fixed-frequency transmon qubits (5.2-5.8 GHz band) on Si substrate • Next-neighbor fixed-frequency LC couplers • Readout resonators (6.2-6.8 GHz band) coupled to a single readout bus • Chip packaging: Bleximo's Aegis.Qryo platform



Simplified all-digital characterization and cryogenic setups. In our tests, control pulses were generated and qubit readout was performed using a single P9484M module (4 AWGs and 2 Digitizer configuration).

The setup is significantly simpler and cheaper than those using traditional I/Q up- and down- conversion schemes.

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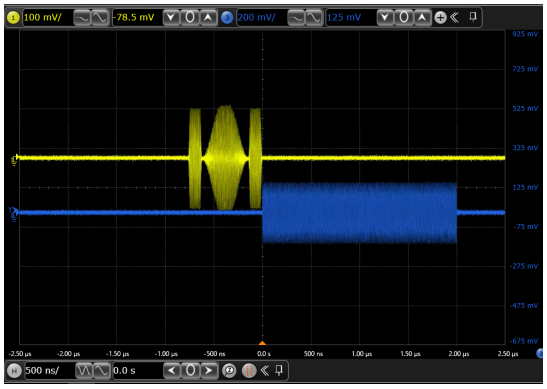
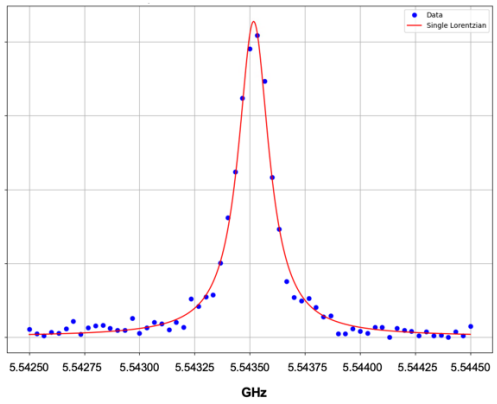
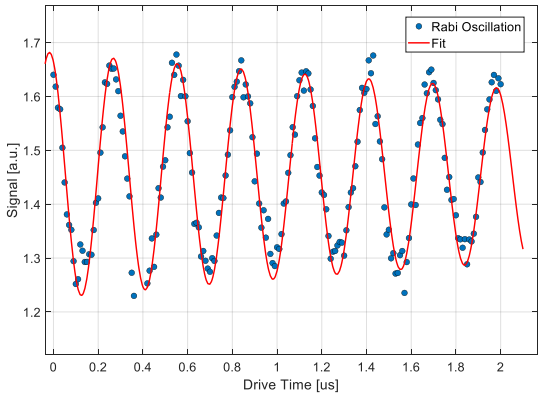
Experimental Data



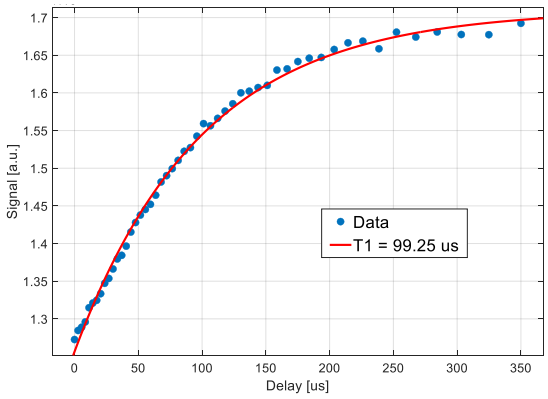
Pulses generated by the control system: yellow pulse is the qubit drive; blue pulse is the readout drive.



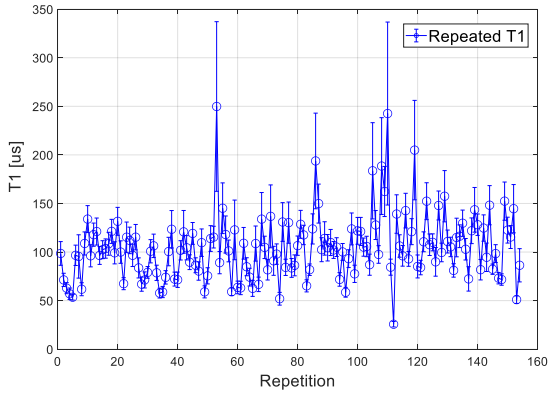
Qubit spectroscopy: qubit frequency is determined by fixing the readout resonator frequency and sweeping the qubit probe frequency.



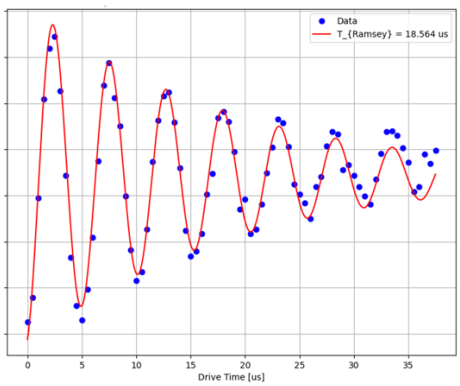
Rabi oscillations: using readout resonator and qubit frequencies, sweep qubit control pulse duration to determine the pi-pulse duration.



T1 relaxation: applying pi-pulses to the qubit, sweep the readout delay.



T1 relaxation: time dependence during 12-hour long measurements



T2 Ramsey experiment to determine the detuning frequency and T_2*

To inquire about commercial availability, please contact:

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