



Quantum Diagnostics Libraries

for superconducting qubit
and TWPA diagnostics



**Professionalize your
quantum chip development**
with our affordable, flexible and
easy to use suite of proprietary
software libraries.

We take care of the professional
development, so you can
focus on the physics.



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Quantum Diagnostics Libraries

Superconducting Qubit Tools (SCQT)

Hardware verification Mixer corrections Latency & Delay corrections	Perform mixer offset calibration, mixer skewness calibration, acquisition delay calibration, microwave readout delay, flux-microwave delay calibration and flux-readout delay.	Mixer offset calibration
Qubit identification Qubit coherence	Perform heterodyne spectroscopy, two-tone spectroscopy (qubit frequency, 1-2 transition), three-tone spectroscopy (1-2 transition), Rabi, relaxation (T1), Ramsey (T2*), Hahn echo (T2 echo), AllXY, flux-tracked protocols, time-tracked measurements, parallelization of time-domain protocols. Coming soon: TLS spectroscopy, support for Purcell filters	Three-tone qubit spectroscopy
Single Qubit Gates & Fidelity Initialization & Readout Fidelity	Perform Motzoi calibration, pulse amplitude flipping calibration, randomized benchmarking (single-qubit, simultaneous single-qubit and with leakage modification), gate set tomography. Perform single-shot readout and optimal weights calibration. Coming soon: measurement-induced dephasing and AC Stark shift	Single-shot readout
Two-Qubit Gates & Fidelity	Perform Cryoscope-based flux distortion corrections, multiplexed readout, Chevron interference experiments, conditional oscillations, optimization heatmaps of conditional oscillations, Bell state tomography and two-qubit CZ interleaved randomized benchmarking.	Chevron
Crosstalk characterization	Measure and analyze microwave drive crosstalk, DC flux crosstalk, Residual ZZ coupling, measurement crosstalk Coming soon: Measurement-induced dephasing and AC Stark shift characterization and DC flux crosstalk corrections	Residual ZZ coupling

TWPA Tools

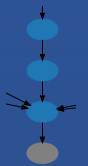
Modes of Operation	Activate, deactivate and bypass TWPA. Measure TWPA transmission and reflection signals, if supported by hardware setup.	TWPA gain ripple
Measurements & Analyses	Measure signal strength, noise spectrum, gain compression, gain ripple, quantum efficiency (req. SCQT) Perform measurement sweeps versus flux bias, probe frequency, pump frequency, probe power, pump power	TWPA gain compression

GRAph-based Automated Calibration Execution (GRACE)

Automate your SCQT or TWPA Tools with GRACE, our software library for graph-based automation of diagnostics.

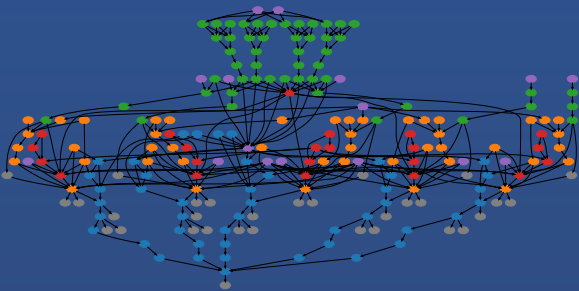


Every node in the graph represents a protocol, which is a physics experiment.



Using a standardized sequence of experiments, GRACE measures device quantities of interest in the proper order.

This allows GRACE to build a dependency graph for your quantum device diagnostics



- Define custom chains of protocols
- Monitor progress of quantum chip diagnostics
- Visualize dependencies between protocols
- Automate execution of protocol sequences
- Reduce idle overhead between protocols



Watch GRACE at work in this recording of automated testing of a transmon qubit on [YouTube](#).

Requirements

Quantum Diagnostics Libraries need to use a qubit control stack, auxiliary electronic equipment and a control PC to execute their diagnostics.

Most instruments with QCoDeS drivers can be used in your custom setup. We test Quantum Diagnostics Libraries on the following instruments.

Qblox

- QCM & QCM-RF
- QRM & QRM-RF
- Cluster

Zurich Instruments

- HDAWG
- UHFQA

Rohde & Schwarz

- VNA

Signal Hound

- Spectrum Analyzer

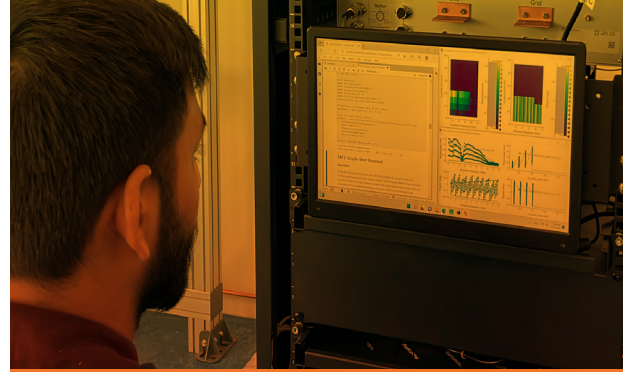
When using the Quantum Diagnostics Libraries, we recommend using a control PC with at least the following specs:

- 1 TB storage
- 16 GB RAM
- Intel i7 Processor

For a plug-and-play experience of the Quantum Diagnostics Libraries, consider the purchase of an Orange Rack or Orange R&D System. These products ensure high standards for signal quality, connectivity and tight integration between hardware and software, which is required to guarantee automated diagnostics.

For information & ordering, contact sales@orangeqs.com

Know your quantum chip.



Scalable & customizable to your needs

Speed up your quantum device diagnostics and focus on the physics!

Hit the ground running with software that is professionally developed and maintained. Use our extensive documentation to get familiar with the tools, physics and syntax.

Extend the functionality of our Quantum Diagnostics Libraries according to your needs and receive support:

- Seamless integration with the open-source Quantify framework
- Measurement and analysis protocols for most common experiments
- Develop using pulse-level simulator, based on Lindblad equation.

Our software is tested extensively using modern software engineering practices, like version control, regular releases and CI/CD.

