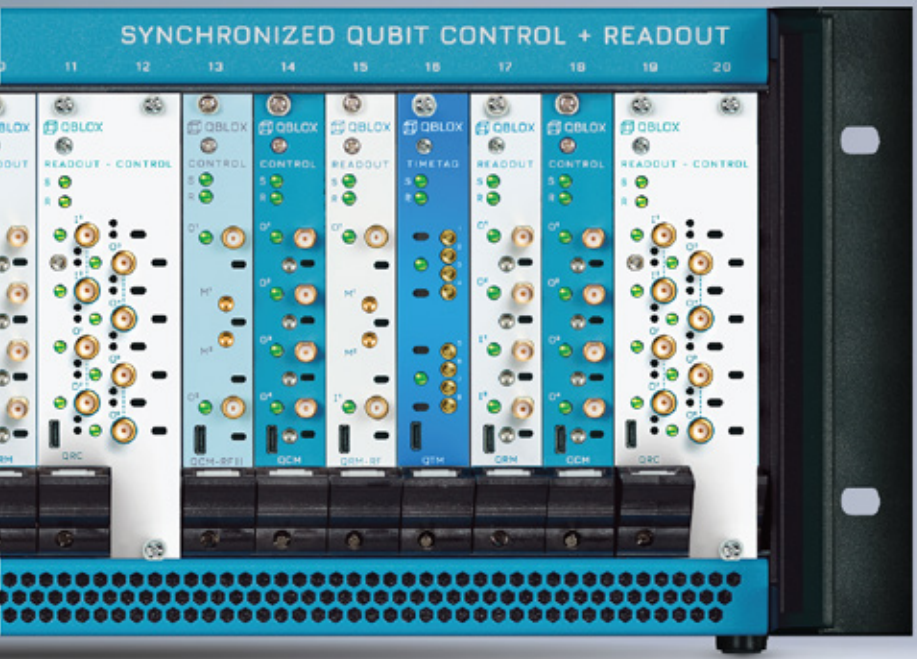
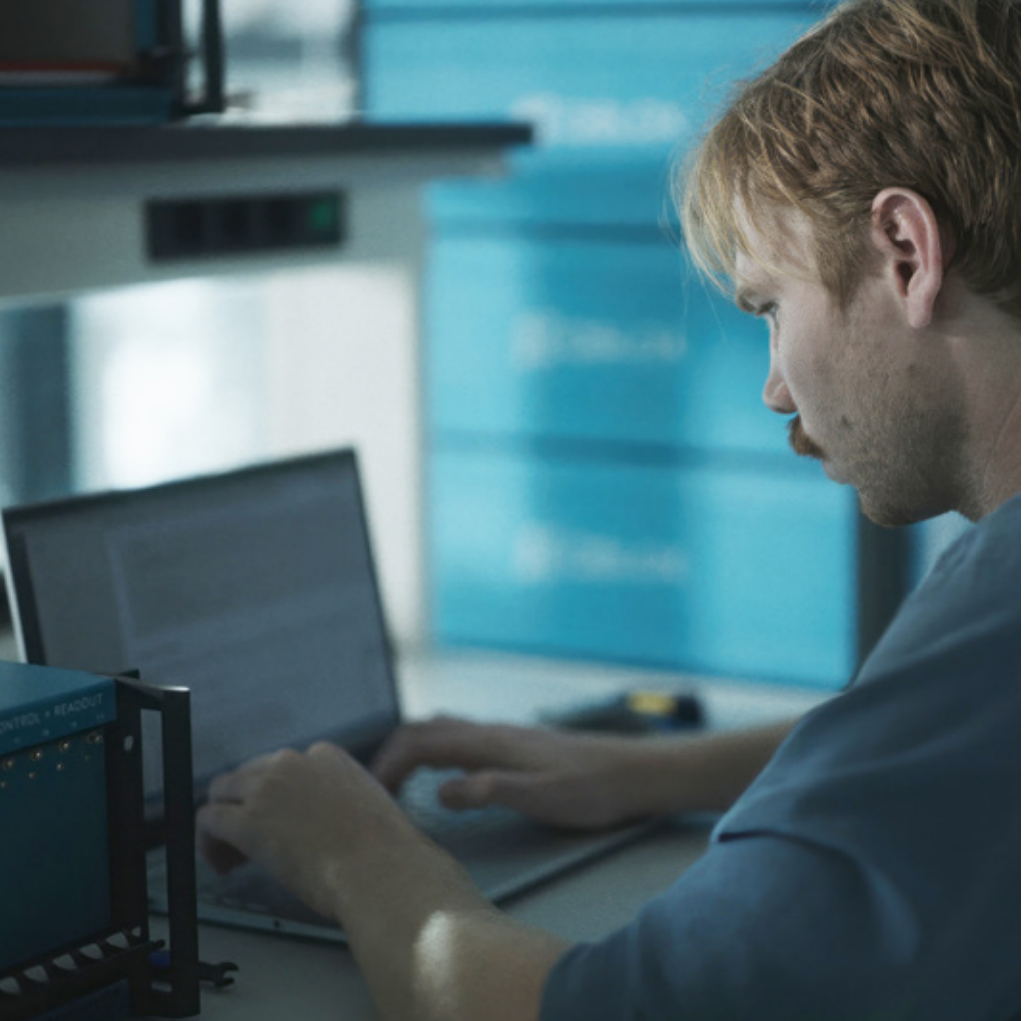
Quantum control stacks



QBLOX


QBLOX

Index



Qblox

Ultra scalable and fully-integrated quantum control

With a team of 170+, Qblox is a leading provider of modular, fully integrated, and scalable quantum control electronics. We offer precision control with the accuracy for error correction required to advance quantum setups beyond NISQ applications.

The Qblox Cluster control stack integrates key technologies for pulse generation and acquisition, supporting different qubit types.

With our solutions for quantum control and readout, academic and industrial customers worldwide can scale their setups to hundreds or even thousands of qubits. We believe in the power of collaboration and are dedicated to supporting your quantum journey.

Control the quantum future by visiting www.qblox.com.

The Cluster series control stack

Control and readout, integrated

The Cluster series control stack incorporates digital pulse processing and analog excellence to control quantum computers.

The analog modules cover a wide frequency range, while the digital module offers state-of-the-art timetagging. By configuring the correct modules, your setup can be tailored for the ideal superconducting qubit, spin qubit, or optically addressable qubit control and readout. Each module provides precise synchronicity and all-to-all connectivity between channels. The top-of-the-line scalable architecture with high channel density enables research labs and industry to scale from a handful of qubits to hundreds seamlessly.

The Cluster 19” mainframe encompasses distributed intelligence where control and readout tasks are orchestrated on the nanosecond scale by multiple cores of Q1 sequence processors, speeding up experiments by orders of magnitude. The scalable architecture and customizable software stack ensure that the system is future-proof and well-aligned with the development roadmaps of industrial labs and the growing demands of quantum experiments.

Module overview

Build your ideal setup with streamlined control

DC module

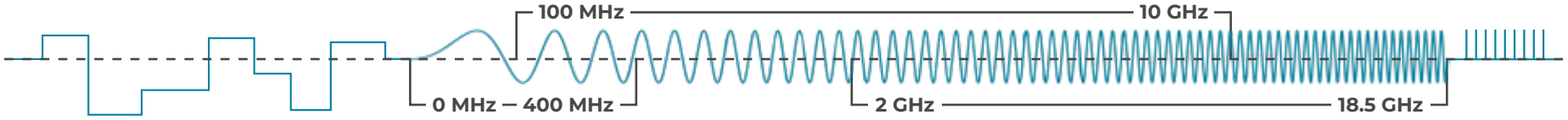
QSM
Source & Measure
8 Inputs/Outputs

BB/RF modules

QRC
2 Inputs
6 Outputs

Digital modules

QTM
Timetag module
8 Digital I/O



Check our products

QCM
4 Outputs

QRM
2 Inputs
2 Outputs

QCM-RF
2 Outputs

QRM-RF
1 Input
1 Output

0 - 400 MHz

QUBIT CONTROL MODULE

Ultra-low noise and real-time signal generator with distortion correction

4 Output channels
5 Vpp

16 bits
16k wave memory

4 Digital outputs

1 GS/s sampling rate

QUBIT READOUT MODULE

Readout module for signal generation, acquisition, and onboard data processing

2 Output channels / 1 Vpp
2 Input channels / 0.1 - 2 Vpp

12 bits
16k wave memory

4 Digital outputs
1 GS/s sampling rate

2 - 18.5 GHz

RF QUBIT CONTROL MODULE

Direct RF signal generator up to 18.5 GHz with high SFDR

2 Output channels
Max output power +10 dBm
Attenuation range 30 dB

720 MHz bandwidth
16 bits
16k wave memory

2 Digital outputs
1 GS/s sampling rate

RF QUBIT READOUT MODULE

Multiplex readout up to 18.5 GHz

1 Output channel / -40 to +5 dBm
1 Input channel / -26 to 0 dBm

750 MHz analog bandwidth
12 bits
16k wave memory

2 Digital outputs
1 GS/s sampling rate

100 MHz - 10 GHz

QUBIT READOUT AND CONTROL

QRC

Complete RFSoC based solution for qubit control and readout up to 10 GHz

6 analog outputs, 2 analog inputs

12 Q1 Sequencers
(8 Readout, 4 Control)

Analog bandwidth:
800 MHz

5 GS/s DAC/ADC rate

Calibration-free

DIGITAL I/O

QUBIT TIMETAG MODULE

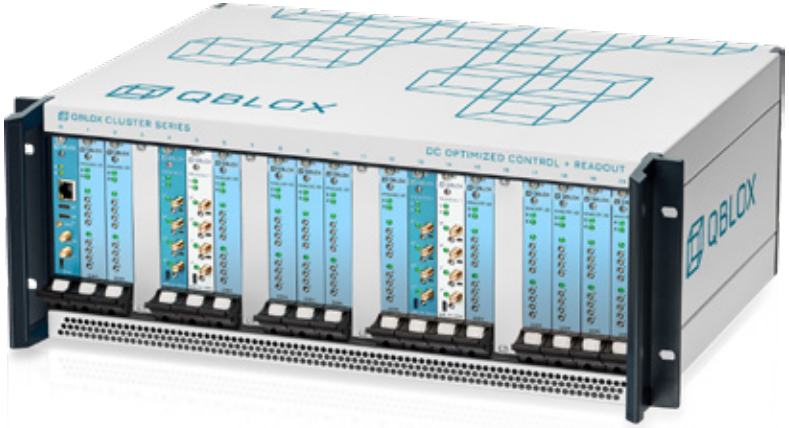
QTM

Timetagging module with
8 configurable digital inputs
and outputs

1.5 V (50 Ohm) / 3.1 V (high-Z)
39 ps control resolution

20 ps readout resolution
Rising edge detection

Trigger counting
Input gating



The DC Cluster

The Qblox DC Cluster mainframe is a 19” rack designed for DC transport experiments. It offers ground-loop free operation and interference isolation. The mainframe can host up to 20 modules, supporting QSM Quantum Source and Measurement modules, along with QCM and QRM baseband modules.

Key features of the DC Cluster include

- Optimized mainframe for ultra stable DC signals
- Up to 160 DC channels in a single mainframe
- The ability to operate QCM and QRM modules together with QSM
- A safety ramp-down feature for emergencies

QUANTUM SOURCE AND MEASUREMENT

8 re-configurable DC input and output channels.

28-bit resolution over +/- 10 V voltage sourcing range.
Up to 50 mA current sourcing.

µV voltage measurement range.
pA-mA current measurement range.

Simultaneous (gate) leakage current monitoring.
Safe ramp down emergency switch

Qblox Scheduler

Quantum control made simple

Qblox Scheduler is a high-level software package designed to simplify quantum control workflows, moving you faster toward your next breakthrough.

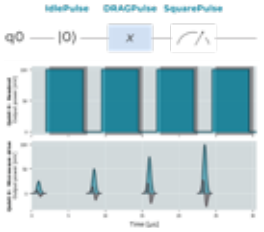
Kickstart your measurements instantly using an extensive library of pre-built experiments and step-by-step tutorials. This platform is built with ease of use in mind to drastically minimize programming overhead, empowering you to focus entirely on the physics rather than software complexities.

Meanwhile, the Hardware Agent automates complex loop management, effortlessly maximizing system capabilities. By integrating this with a unique hybrid gate-and-pulse syntax, a Pulse Visualizer for quick debugging, and direct access to auto-generated plots, the software removes friction—giving you the data you need to dive straight into the science.

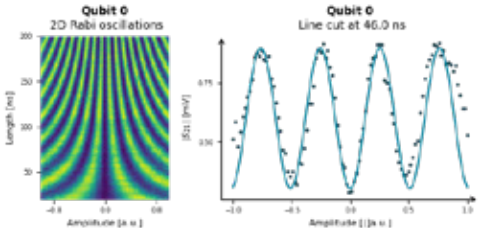
HARDWARE AGENT
Automated hardware optimization

REAL-TIME & NEAR-TIME LOOPS
Execute n-dimensional sweeps

SCHEDULES
Define experiments with streamlined UI/UX



DATA ACQUISITION
Comprehensive and accessible results



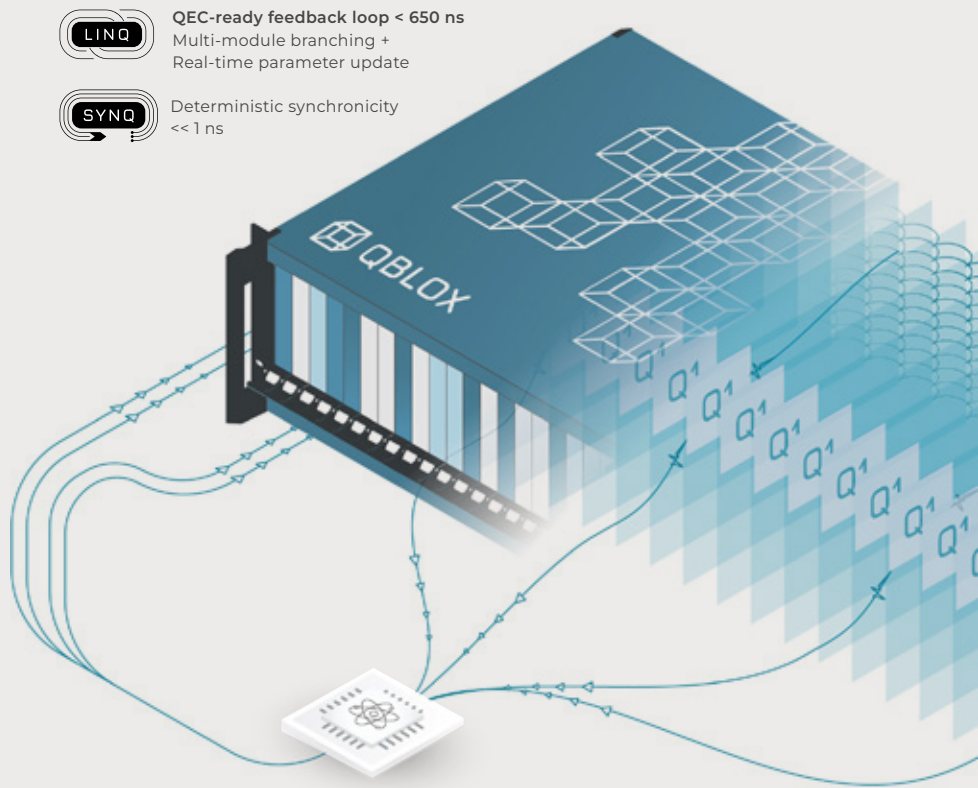
Future-proof scalability with SYNQ and LINQ

Fast Scalable Feedback

Scaling to thousands of qubits demands conquering three critical challenges: low latency, massive data throughput, and flawless determinism for real-time operations. SYNQ and LINQ form Qblox's revolutionary proprietary backbone to accelerate the path to fault-tolerant quantum computing.

SYNQ delivers sub-nanosecond synchronization, while LINQ flawlessly executes dynamic decisions precisely on schedule. This provides immediate value for today's noisy qubits, driving quantum error correction and real-time feedback applications such as rapid parallel active reset and qubit frequency tracking.

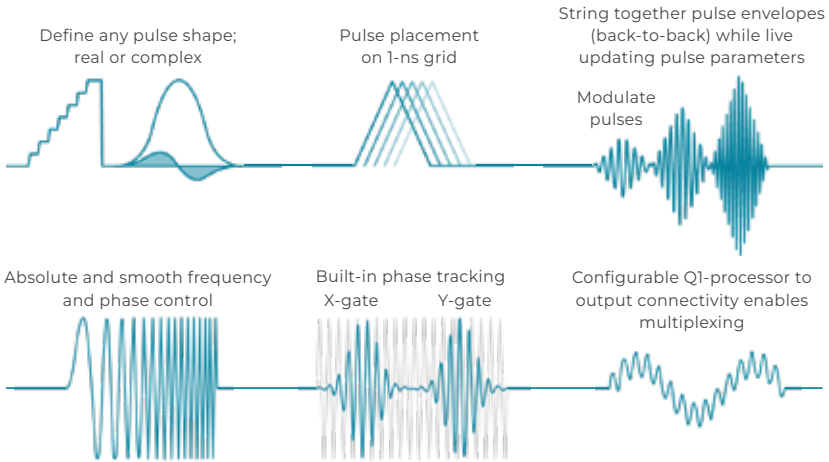
Crucially, LINQ is a data highway built for real scaling. Pushing Cluster-wide 2 Gbps throughput, it effortlessly handles heavy error-correction payloads without bottlenecks. This open, future-proof architecture natively integrates with specialized decoders, giving you total freedom for your R&D roadmap.



Q1 sequence processor

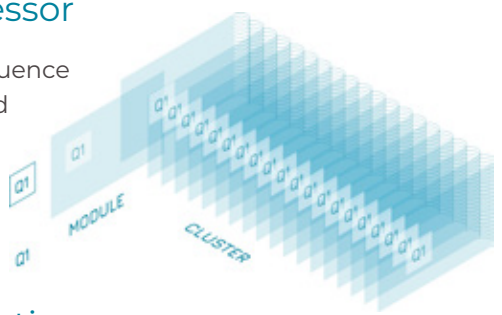
Real-time pulse generation and on-board data processing

The Q1 sequence processor enables powerful and customizable qubit control and readout operations. Real-time pulse sequencing and processing eliminate large overheads in software-controlled loops, avoid uploading lengthy sequences, and minimize data transfer latency through on-board data processing.



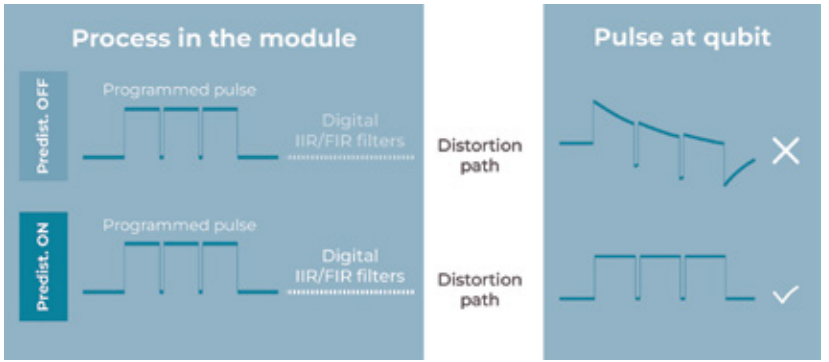
Q1 sequence processor

Multiple cores of Q1 sequence processors are integrated in each module, creating a distributed intelligence over the whole Cluster mainframe.



Real-time predistortion

The Cluster QCM effectively compensates for setup and on-chip induced distortions using digital real-time predistortion filters.

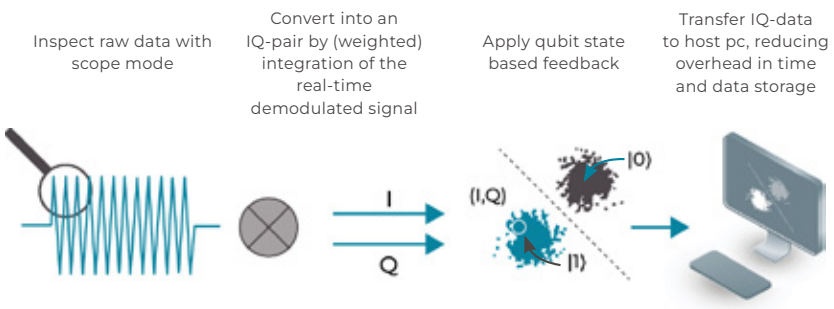


Data acquisition

Qblox Cluster seamlessly integrates signal generation with signal acquisition to optimize time orchestration, ensure phase-locked setups, and enable fast measurement-based conditional feedback.

Scope acquisition mode facilitates inspection and processing of the raw input signal. This simplifies time-of-flight calibrations and debugging purposes.

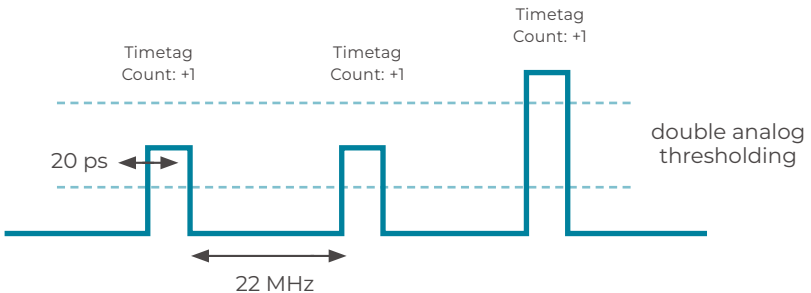
On-board processing power effortlessly demodulates the incoming signal in real-time. Follow this, the signal is converted into an IQ-pair via (weighted) integration. IQ rotation and discretization enable measurement-based feedback across the whole Cluster.



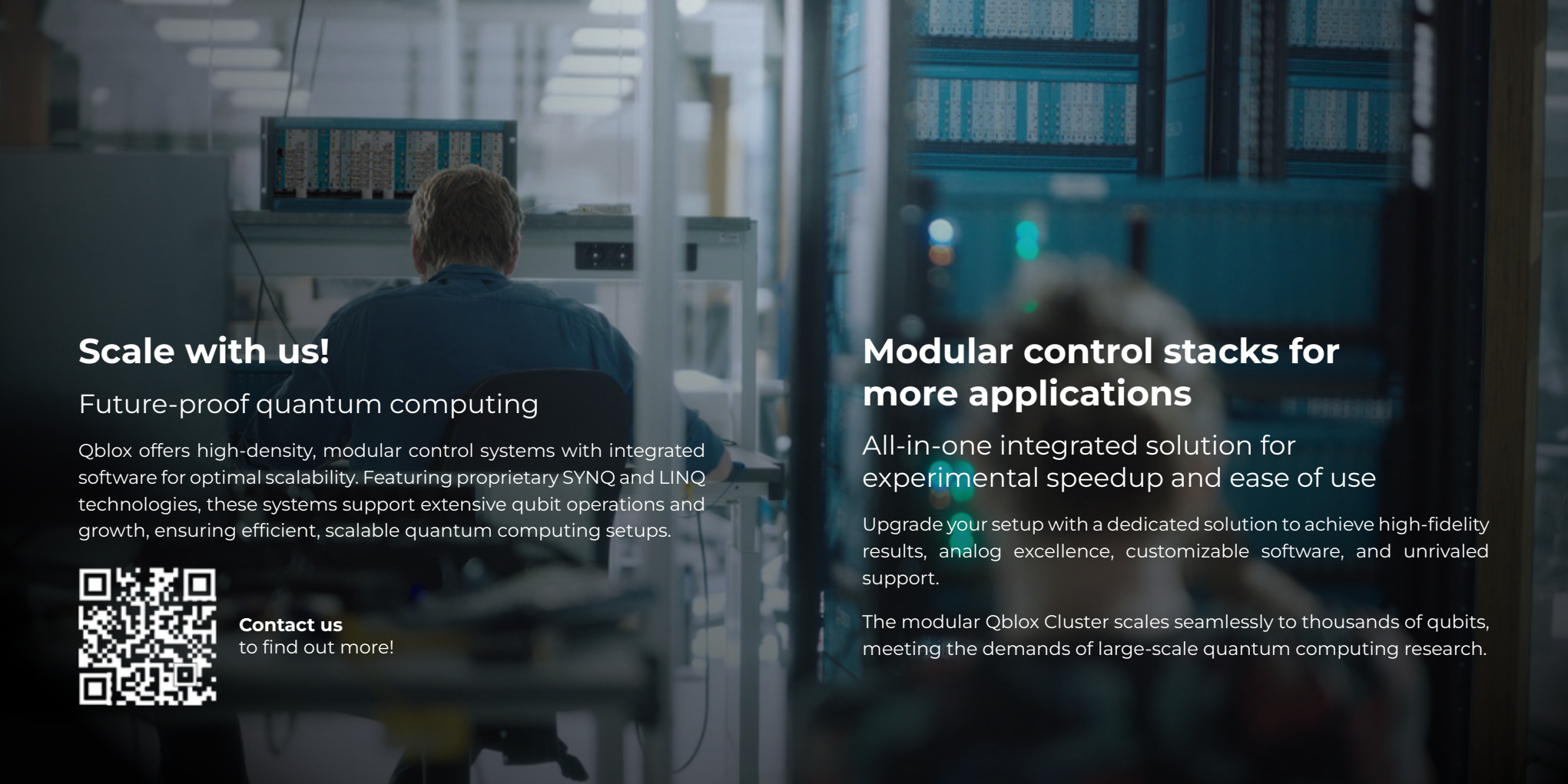
TTL acquisition

Cluster QTM offers TTL signal readout from photodetectors. Rising edge detection based on a configurable (double) analog threshold enables photon counting and timetagging.

Incidence measurements between two channels enables time-based multi-photodetector measurements. High-precision windowing mitigates dark counts. This embedded solution facilitates fast conditional feedback based on photon counts.



Check out the Qblox instruments webpage for tutorials and application examples



Scale with us!

Future-proof quantum computing

Qblox offers high-density, modular control systems with integrated software for optimal scalability. Featuring proprietary SYNQ and LINQ technologies, these systems support extensive qubit operations and growth, ensuring efficient, scalable quantum computing setups.

Contact us
to find out more!

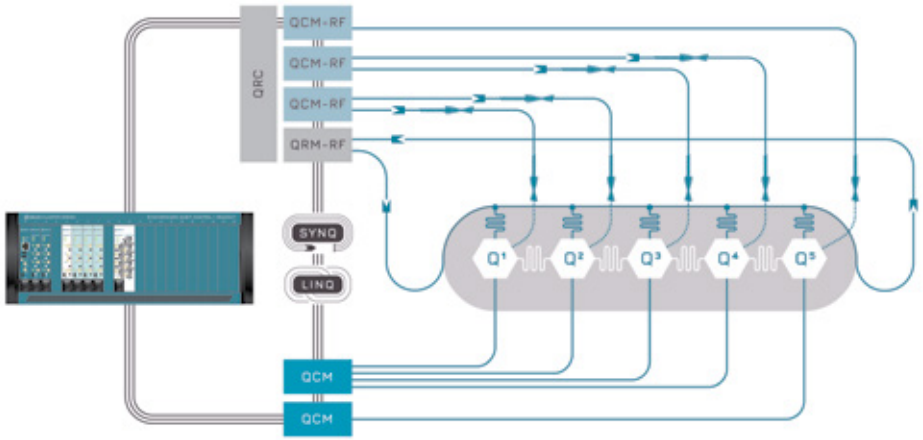
Modular control stacks for more applications

All-in-one integrated solution for experimental speedup and ease of use

Upgrade your setup with a dedicated solution to achieve high-fidelity results, analog excellence, customizable software, and unrivaled support.

The modular Qblox Cluster scales seamlessly to thousands of qubits, meeting the demands of large-scale quantum computing research.

5 Transmons



QCM-RF — MW drive lines
Single-qubit operations
2 - 18.5 GHz

QRM-RF — Readout feedline
Frequency-multiplexed
readout 2 - 18.5 GHz

QCM — Flux lines
Two-qubit operations

QRC — MW drive lines & readout feed lines
Frequency multiplexed readout
0.1 - 10 GHz

SYNQ — Deterministic timing
Intermodular protocol

LINQ — Fast Scalable Feedback
All-to-all connectivity

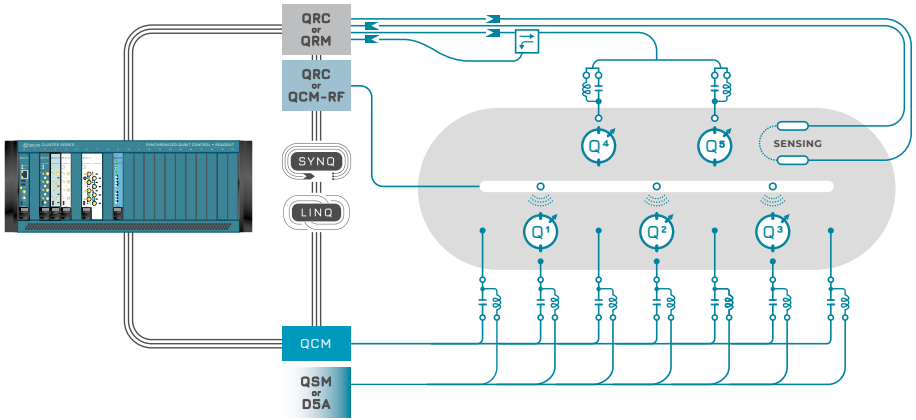
Superconducting qubit control and readout

Unlock high-fidelity results faster with our key features, including:

- Parallel operations together with frequency multiplexing, enabling large-scale computing
- Ultra-low 1/f noise and minimal drift, ensuring precise flux pulsing and DC offset generation
- Fast, scalable feedback for active reset and quantum error correction
- On-board data processing to enable weighted averaging and reduce data transfer latency
- Intuitive software package to simplify quantum experiments with libraries of quantum operations, calibration routines, and visualization

QBLOX Scheduler

5 Quantum dots



QRM — RF-reflectometry and DC readout at 0 - 400 MHz.

QRC — RF-Reflectometry and Qubit Control at 0.1 - 10 GHz.

QCM-RF — Qubit control by ESR and EDSR experiments at 2 - 18.5 GHz.

QSM or D5A — Ultrastable DC voltage sources for setting barrier and quantum dot potentials.

SYNQ — Deterministic timing Intermodular protocol

QCM — Control quantum dots by fast gate pulses at 0 - 400 MHz.

LINQ — Fast Scalable Feedback All-to-all connectivity

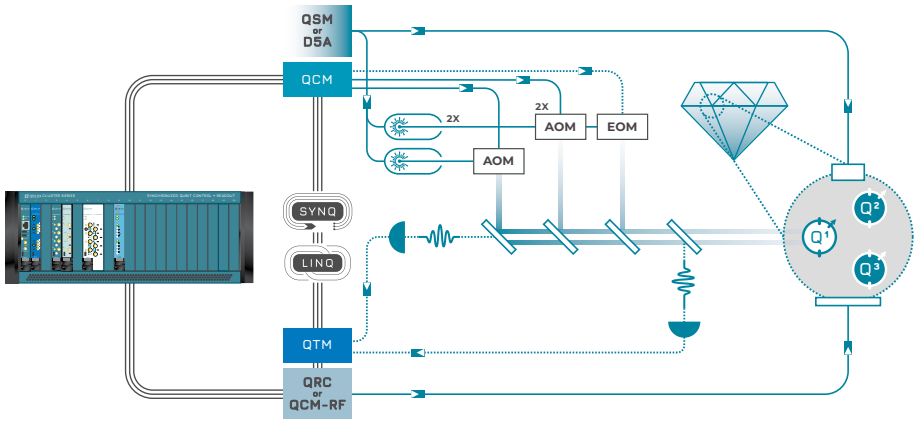
Spin qubit control and readout

Unlock high-fidelity results faster with our key features, including:

- Fast charge scans due to minimized overheads
- Multi-tone RF-reflectometry readout between 0 to 18.5 GHz
- Ultra-low 1/f noise for precisely tuned quantum dot potentials
- Pulse resolution on a 1-ns time grid for high-fidelity operations
- Real-time correction of setup-induced distortions (e.g., bias-tee compensation)
- Monitoring leakage current upon a gate breakdown on voltage output channel, simultaneously
- Intuitive software package to simplify quantum experiments with libraries of quantum operations, calibration routines, and visualization

QBLOX Scheduler

Color center register of 3 qubits



QTM — Digital I/O module for direct laser control, photon counting and time tagging supporting fast feedback

QRC — Qubit control of the spin-state of the defect center from 0.1 - 10 GHz

QSM or D5A — Ultrastable DC voltage sources for laser control and tuning energy levels in-situ.

QCM-RF — Qubit control of the spin-state of the defect center from 2 - 18.5 GHz

SYNQ — Deterministic timing Intermodular protocol

QCM — DC - 400 MHz source to drive AOM and EOMs to shape laser pulses

LINQ — Fast Scalable Feedback All-to-all connectivity

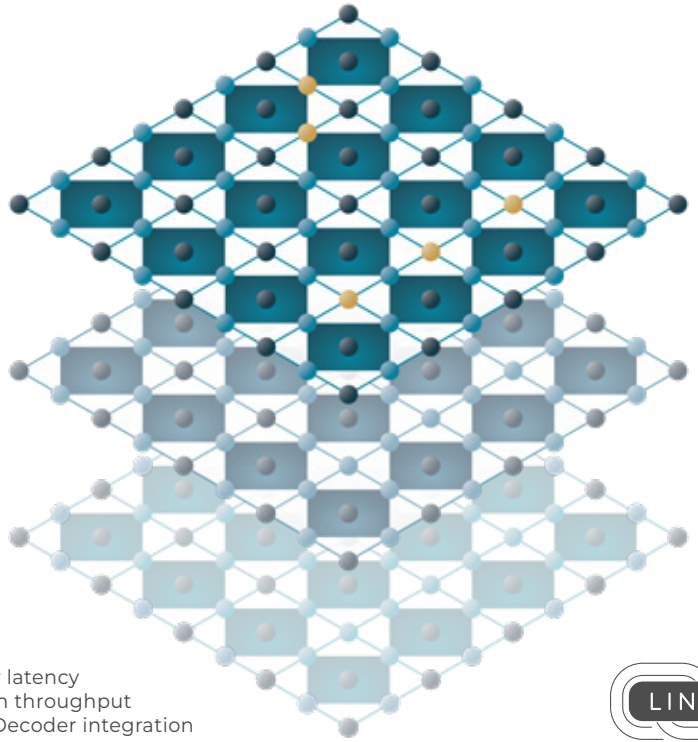
Optically addressable qubit control and readout

Unlock high-fidelity results faster with our key features, including:

- Photon counting and timetagging via a configurable analog threshold
- Configurable lookup tables for coincidence detection protocols up to 4 channels
- Relative timetagging between channels for correlation measurements
- Photon count-based conditional feedback for in-experiment charge-resetting
- Frequency multiplexed outputs for manipulating registers
- Seamless phase tracking, factoring in frequency updates and phase kicks
- Intuitive software package to simplify experiments with a quantum operations library, analysis, and visualization tools

QBLOX Scheduler

Quantum error correction



✓ Low latency
✓ High throughput
✓ RT Decoder integration

LINQ

The threshold to fault tolerance

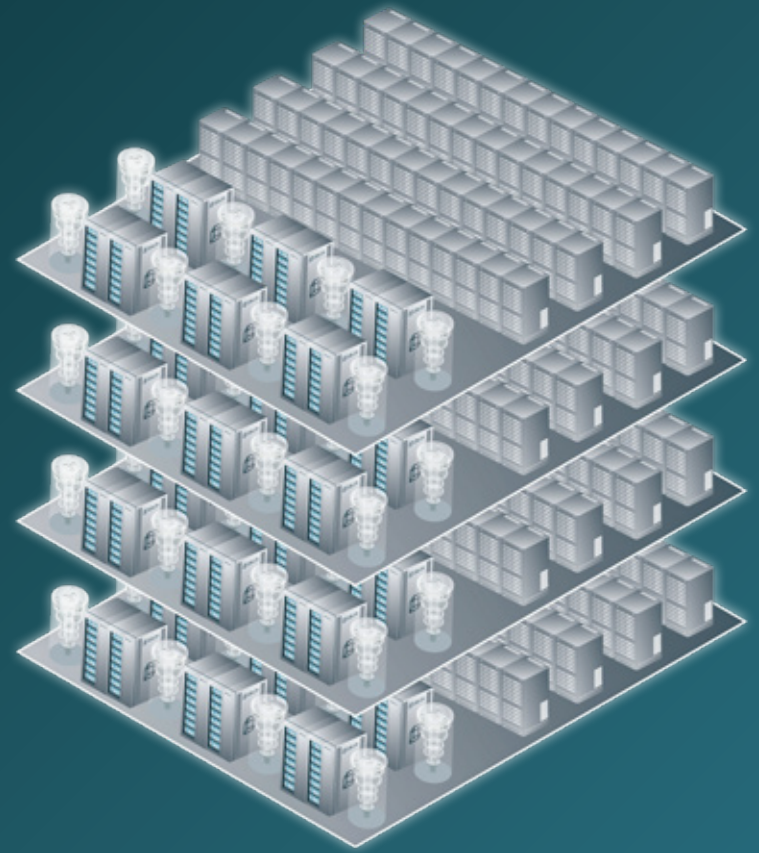
In order to conquer the strict demands of quantum error correction, Qblox uniquely delivers a scalable, QEC-ready feedback architecture featuring ultra-low latency, all-to-all connectivity, massive data throughput, and seamless real-time decoder integration. This platform is powerfully combined with excellent analog performance and advanced pulse processing to accelerate your transition to fault tolerance.

LINQ guarantees a deterministic QEC-ready feedback loop of less than 650 ns, perfectly executing multi-module branching alongside real-time parameter updates. This ensures lightning-fast error correction while seamlessly routing heavy syndrome payloads without dangerous bottlenecks. Furthermore, LINQ acts as a high-speed bridge connecting directly to real-time decoders. This open ecosystem allows you to smoothly integrate best-in-class decoders, accelerating your QEC roadmap.

From lab to supercomputer: Quantum execution at scale

The deterministic control layer for seamless, enterprise-grade quantum-classical orchestration

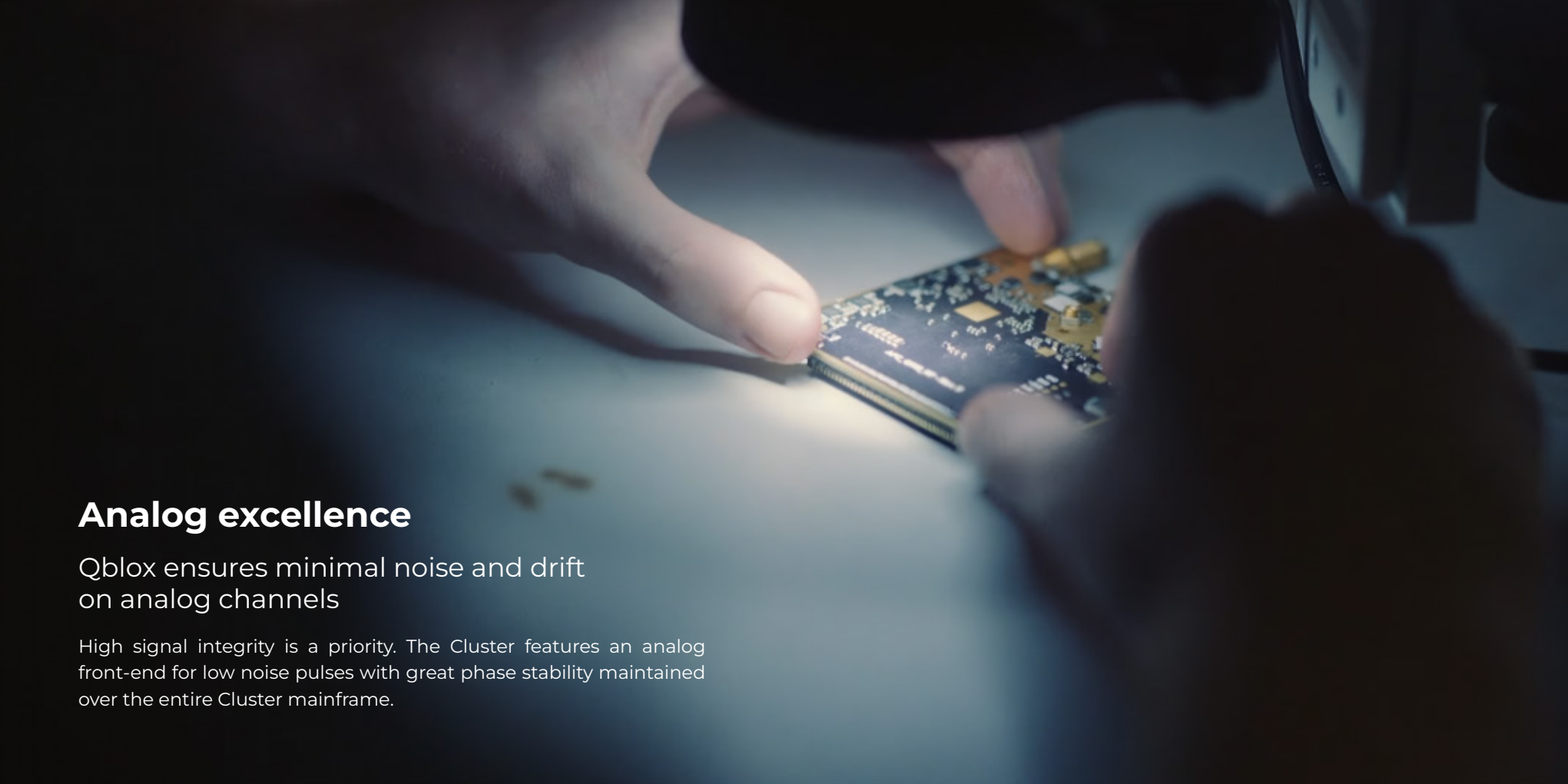
Quantum computing is transitioning from experimental breakthrough to a vital component of the computational stack. For enterprises and HPC centers, the barrier isn't just qubit count, it is system readiness. Integrating quantum hardware into existing AI and HPC workflows requires more than just connectivity; it requires a deterministic, scalable execution layer.



Qblox delivers that layer. Operating as a high-performance quantum execution backplane, Qblox synchronizes control and readout with nanosecond precision. By enabling real-time feedback and complex conditional logic, we transform quantum bespoke lab setups into reliable, repeatable infrastructure.

We solve the “timing gap” in hybrid workflows, ensuring quantum processors perform as predictable accelerators within the HPC environment. Just as the motherboard standardized classical computing, Qblox provides the stability and orchestration needed to deploy enterprise-ready quantum systems today.

Barcelona Supercomputing Center (BSC-CNS), on your right, is a leading European HPC hub in Barcelona, home to the MareNostrum infrastructure. There, **Qblox** and **Qilimanjaro** support the integration of superconducting quantum systems through a scalable control stack for hybrid quantum-classical deployment.



Analog excellence

Qblox ensures minimal noise and drift on analog channels

High signal integrity is a priority. The Cluster features an analog front-end for low noise pulses with great phase stability maintained over the entire Cluster mainframe.

Quantum workforce development

A strategy that prepares quantum professionals for tomorrow's technologies

Qblox supports workforce development through adaptable training pathways that match the needs of institutions, industries, and technical programs, preparing talent for quantum-related roles. These pathways reflect how Qblox enables educational experiences through scalable, modular, and user-friendly control electronics that prepare a ready quantum workforce.

Full-stack workforce training provides complete quantum education setups where Qblox hardware and partner solutions enable hands-on learning in qubit control, measurement, and system integration.

Integrated partial or entry-level setups support engineering curricula by offering practical experience in signal generation, measurement, and experiment workflows without requiring a full quantum stack.

Standalone skills development enables departments to teach core control and measurement concepts using Qblox hardware for signal generation, data acquisition, and hardware control training.

Quantum success engineering

Extension of your lab

Your research goals are our priority. Our support team of experts, with backgrounds in experimental physics and electrical engineering, ensure that you have the features you need to reach your goals with reliable results.

Our aftersales support includes:

- Onboardings and on-site training
- Direct 24/7 access to or quantum engineers
- Minimized downtime with robust RMA processes
- Free-of-charge features with firmware upgrades

Building Quantum, Together!

Save time and unlock analog excellence, scalability, and the flexibility of open-source software with the Qblox control stack.

Experience the efficiency of our products firsthand with personalized live demonstrations from one of our expert application scientists. Request a demo today and discover how our solutions can empower your business to thrive.

www.qblox.com


QBLOX

Building Quantum, Together.

www.qblox.com

Release February 2026_V2.0