QBLOX

QSM / Quantum Source and Measurement Module
DC Cluster | 19" Rack Mounted

Release January 2026_V1.22

Description

The Quantum Source and Measurement (QSM) module is developed for DC transport experiments, qubit characterization and qubit operations with DC pulses. It integrates sourcing and measurement capabilities in a single instrument.

The QSM module is supported by the DC Cluster mainframe, guaranteeing ground-loop-free operation, interference isolation, and long-term stability.
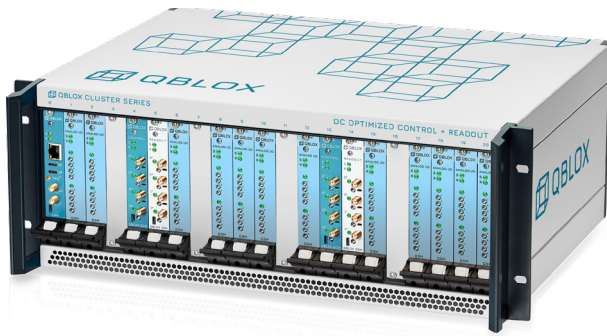
Scalable and modular
With 8 channels per QSM and up to 20 modules in the DC Cluster, a maximum of 160 reconfigurable input/output channels are available for DC transport experiments and qubit operation.

Excellent performance
The QSM and DC Cluster are designed to provide long-term stable output at ultra-low noise level. Thanks to its dedicated mainframe, DC-optimized Cluster completely avoids interferences and ground loops.

Fast time to results
QSM modules seamlessly operate together with other Qblox baseband modules within the DC cluster ensuring rapid transition to experiments.
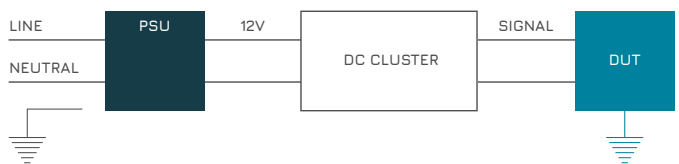

Key benefits - QSM

• Source and measurement of current and voltage in a single module via 8 re-configurable DC input and output channels.

• 28-bit resolution with <0.6 µV step size.

• +/- 10 V voltage sourcing range.

• Up to 50 mA current sourcing.

• Down to 10 µV voltage measurement range.

• 1 pA to 50 mA current measurement range.

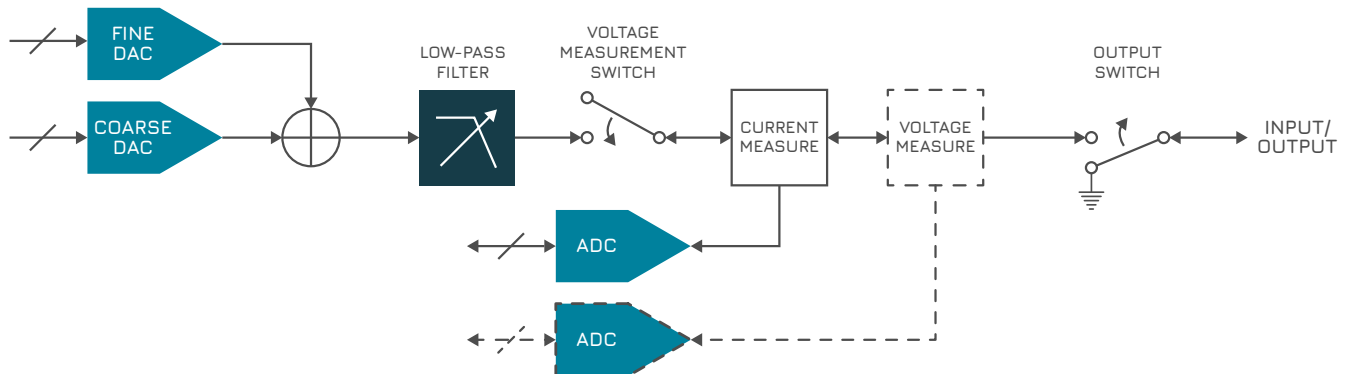• Simultaneous (gate) leakage current monitoring.

Key benefits - DC Cluster

• Ground-loop and interference isolation.

• Safety ramp-down switch.

• 20 slots to support QSM modules, along with QCM and QRM baseband modules.
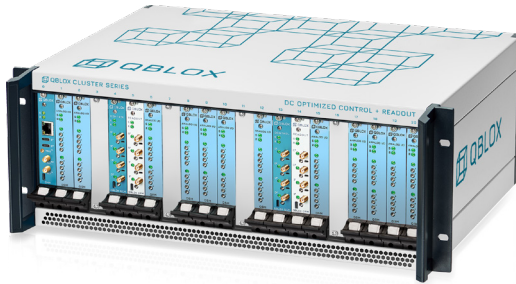
• Up to 160 channels in a single 19" Cluster.

Ground loop isolation architecture of DC Cluster

Input/output diagram of QSM

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QSM / Quantum Source and Measurement Module
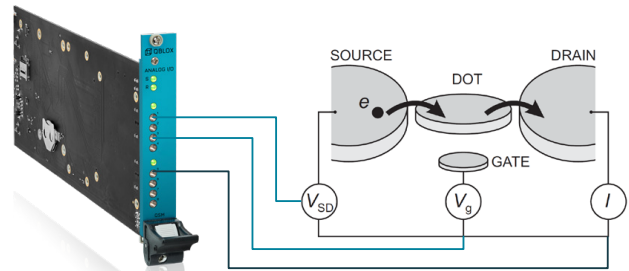# DC Cluster | 19" Rack Mounted

DC optimized Cluster for Control and Readout

Qblox upgrades its DC solution with the new Quantum Source and Measurement (QSM) module and the DC Cluster. Along with its sourcing function, the measurement capability of the QSM makes it a unique instrument for transport experiments and qubit applications.

The DC Cluster mainframe supports up to 20 QSM modules. Its modular design allows integration with Qblox's QCM and QRM baseband modules within a single 19" DC Cluster mainframe. This makes the DC Cluster a fully integrated system that provides all essential functions for DC transport experiments in various device concepts.

Semiconductor Devices and Spin Qubits

- Source and measurement of gated micro/nanostructures and devices (transistors, quantum dots) from a single module.

- Up to 10 V gate voltages for high-k gate dielectrics.

- Monitoring leakage current upon a gate breakdown on voltage output channel, simultaneously.

- In spin-qubit experiments, static DC voltage source for tuning quantum dot potentials in long-term operations.
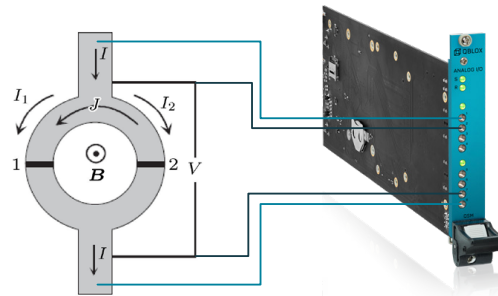

The schematic shows how QSM is used in a typical quantum dot architecture.

Quantum dot illustration is re-used from, Hanson, R. (2005). Electron spins in semiconductor quantum dots (PhD Thesis).

Superconductor Devices and Superconducting Qubits

- Complete I/V characterization of (hybrid) superconducting materials and devices (JJs, SQUIDs).

- Precise source biasing through the charge transport channel with 28-bit output resolution.

- Multi-gate operation for tuning the device properties up to 10 V.

- Monitoring leakage current upon a gate breakdown on voltage output channel, simultaneously.

- In flux-tunable transmon qubit experiments, QSM can be used as bias source for the SQUIDs.
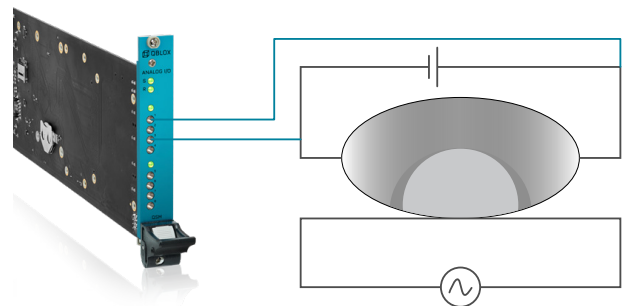

DC-SQUIDs and Josephson junctions are fundamental elements of superconducting qubits. As both devices may operate both at current and voltage biased modes, QSM is an ideal module for such applications.

DC-SQUID illustration is re-used from, Clarke, J., & Braginski, A. I. (2004). The SQUID Handbook (Vol. 1). New Jersey: John Wiley & Sons.

Color Centers, Trapped Ions, and Cold Atoms

- Controlling the electrostatic environment and fine-tuning the drive frequency of NV center qubits.

- Driving optical elements such as modulators, deflectors, piezos, coils to generate an anti-Helmholtz magnetic field, H-bridge, current control of the lasers, etc.

SEM image of an NV center qubit. QSM is used to apply a DC voltage to the blue lines to tune the frequency of the device.

Bernien, H., Hensen, B., Pfaff, W., et al. (2013). Heralded entanglement between solid-state qubits separated by three metres. Nature, 497, 86–90.

QSM / Quantum Source and Measurement Module
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Specifications QSM

Number of I/O channels	8 Configurable I/O

Sourcing / Output	
Voltage and current sourcing	All channels
Output voltage range	+/- 10 V
Output current range (into 50 Ω load)	+/- 50 mA
DC resolution	28 bits (effectively)
Step size	< 0.6 µV
Selectable filter settings	10 Hz, 10 kHz, 250 kHz
Rise time (0 - 1 V step)	32 ms @ 10 Hz 34 µs @ 10 kHz 1.3 µs @ 250 kHz
Temperature coefficient	0.05 ppm / °C of range +0.45 ppm / °C of output
Voltage and current update time	5 ms
1/f noise @ 100 Hz Output: 10V, filter: 250 kHz	<20 nV/√Hz

Measurement / Input	
Current measure	All channels
Voltage measure to ground	Channel 1 and 5
Voltage measure resolution and range	10 µV @ ±10 V scale
Current measure range	0.5 pA to 50 mA
Current measure resolution	0.5 pA @ 0.5 pA - 10 nA range 1 nA @ 1 nA - 10 µA range 1 µA @ 1 µA - 50 mA range
Voltage measure sample rate	250 ksps
Current measure sample rate (for 1 nA - 50 mA range)	250 ksps
Compliance current	50 mA
Compliance voltage	10 V
Input impedance	High-Z
Temperature coefficient voltage	2.5 ppm/°C
Temperature coefficient current	pA range: 80 ppm/°C nA range: 15 ppm/°C mA range: 20 ppm/°C
Connector type	SMP
Power consumption	27 W
Power supply	via DC Cluster
Data connection to host PC	1 Gbit/s via DC Cluster
Driver/API	QCoDeS / Python

Specifications DC Cluster

Capacity	20 slots
Max # QSM module	20 modules
Max # QCM and/or QRM modules	10 modules
Ramp to zero switch	1 global switch
Dimensions	482 x 474 x 176 mm³
Power supply	110-230 V / 50-60 Hz
Data connection to Host PC	1 Gbit/s via ethernet