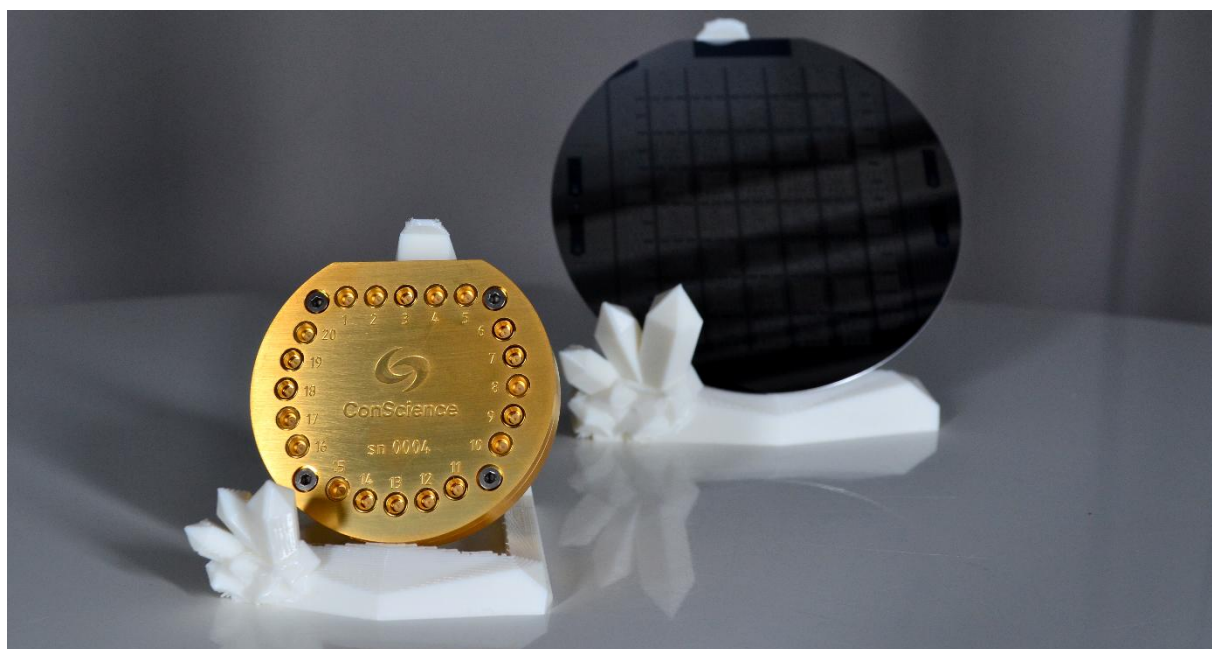


Qubit-in-a-box 1 (QiB1)



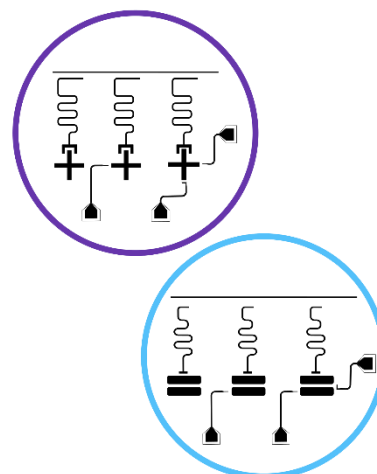
Overview

The QiB1 is a versatile ready-to-use superconducting device - ideal for development, calibration and validation of cryogenic measurement setups, instrument hardware, and control software.

The chip integrates 6 high-coherence single qubits of varying architectures and connection complexities (3-5 GHz), coupled to dedicated readout resonators, along with two additional bare coplanar-waveguide resonators (4.5-7GHz).

Product features:

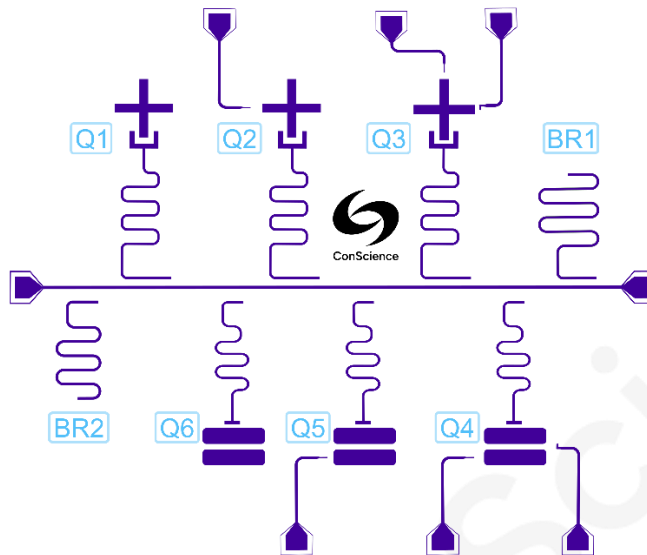
- 6 single qubits in total, arranged into two sets:
 - 3 × shunted Xmon-style transmons
 - 3 × floating-island transmons
- Each qubit set contains distinct qubits with increasing connection complexity:
 - 1 × fixed-frequency qubit driven through its readout resonator
 - 1 × fixed-frequency qubit with a dedicated drive line
 - 1 × tunable qubit with a dedicated drive and flux line
- 2 additional bare resonators



The device is delivered mounted in the Box20: our gold-plated OFHC sample box, connectorized with high-density SMPM connectors. The SMPM connectors may be interfaced with SMA via adaptor cables, provided upon request.

Design parameters – QiB1

The equivalent schematic below shows the various elements on the QiB1 and their connectivity. Qubits are marked with Q, and bare resonators with BR:



The following table shows the design parameters for the frequencies of the qubits f_q , as well as the frequencies of their respective readout resonators, as well as the bare resonators, f_r :

QiB1 design parameters			
	Frequency variability	f_q (GHz)	f_r (GHz)
Qubit 1	Fixed	3.31	4.91 [†]
Qubit 2	Fixed	4.15	6.30 [†]
Qubit 3	Tunable	4.35	6.59 [†]
Qubit 4	Tunable	3.85	6.10 [†]
Qubit 5	Fixed	4.65	6.78 [†]
Qubit 6	Fixed	3.5	5.09 [†]
Bare resonator 1	–	–	5.35
Bare resonator 2	–	–	5.96

[†]Dressed-state frequency

Spec sheet – QiB1 – page 1

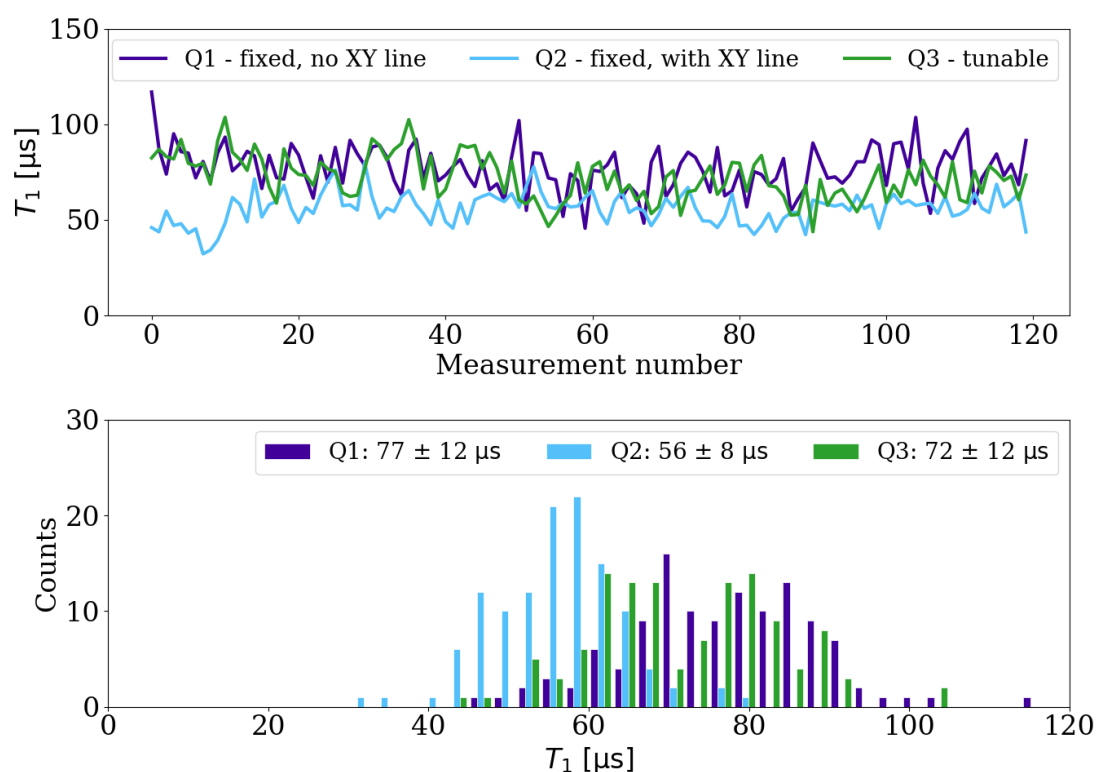
Reference device QiB1-010*

QiB2 measured characteristics			
	f_q (GHz)	f_r (GHz)	T_1 (μ s)
Qubit 1	3.30	5.00 [†]	77
Qubit 2	4.17	6.42 [†]	56
Qubit 3	4.22	6.71 [†]	72
Qubit 4	3.72	6.21 [†]	151
Qubit 5	4.51	6.96 [†]	101
Qubit 6	3.47	5.19 [†]	116
Bare resonator 1	–	5.44	–
Bare resonator 2	–	6.12	–

[†]Dressed-state frequency

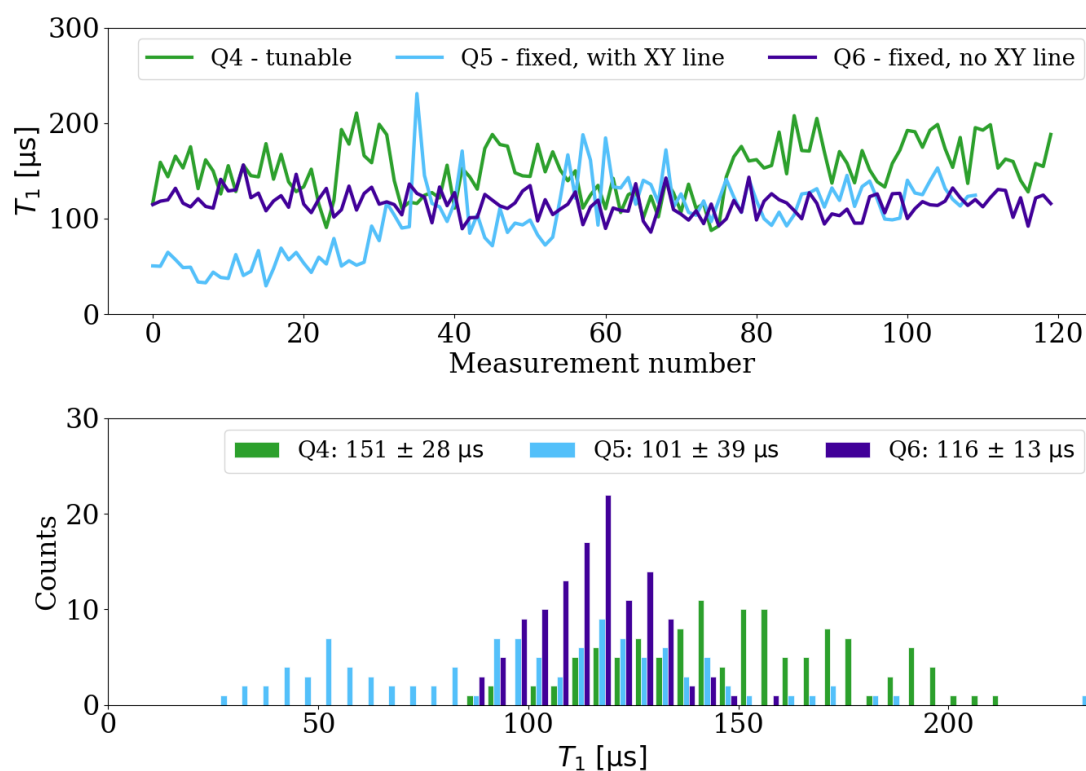
* Specific parameters for each unit are only available for individually characterized products.

Relaxation time statistics for shunted Xmon qubits 1-3:



Spec sheet – QiB1 – page 2

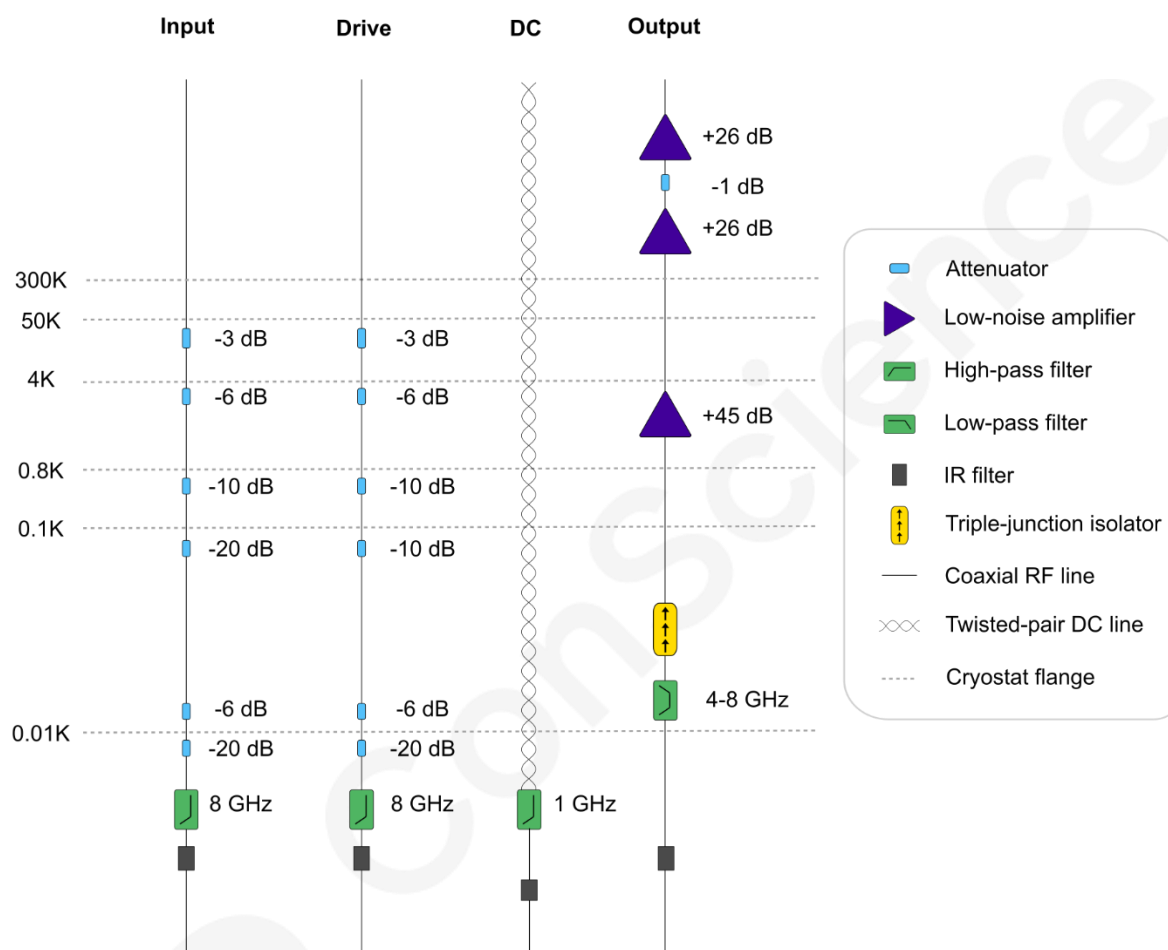
Relaxation time statistics for floating-island qubits 4-6:



Recommended measurement setup

All bare and readout resonators on the QiB1 are coupled to a shared input/output transmission line. Qubits Q2-5 can be driven through a dedicated drive line, and the tunable qubits Q3 and Q4 have a magnetic flux line.

We recommend the following setup for the coaxial RF lines and twisted-pair DC lines:



In the absence of appropriately connectorized twisted-pair lines, the DC line may be routed as a low-attenuation RF line with a near-DC low-pass filter at the device input.

The optimal operating temperature is below 50mK for fixed-frequency elements, and around 10mK for tunable elements.

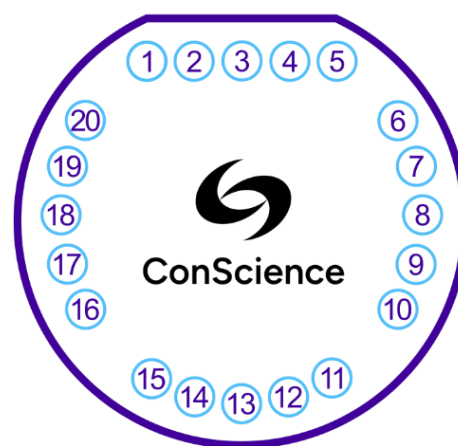
As qubit coherence is strongly impacted by environmental noise, we recommend operating the QiB1 in a dedicated sample space with additional shielding complementing the standard cryostat shielding. Recommended shielding comprises of a dedicated thermal+infrared shield enclosed in a magnetic shield.

Installation

The Box20 is equipped with 20 SMPM connectors arranged in a radial fashion. SMPM-to-SMA adaptor cables can be provided upon request.

1. If using SMPM-to-SMA adapter cables, start by inserting the SMPM side of each cable into the Box20 ports marked in the table below. Keep the adapter cable perpendicular to the Box20 connector and apply force until the connector clicks into place. Do not twist.
2. Mount the Box20 with M3 screws of appropriate length to the lowest temperature stage of a cryostat. The Box20 can be attached from the flat side or the back face. The depth of the threaded hole is 4mm on the flat side of the Box20, and 3mm on the back face. Assure good contact to the mounting plate for sample thermalization. The optimal operating temperature is around 10 mK.
3. Connect the tabulated Box20 ports to the appropriately configured input/output lines of the cryostat. If using SMA connectors, do not over-tighten (required torque 0.3 – 0.6 N·m).

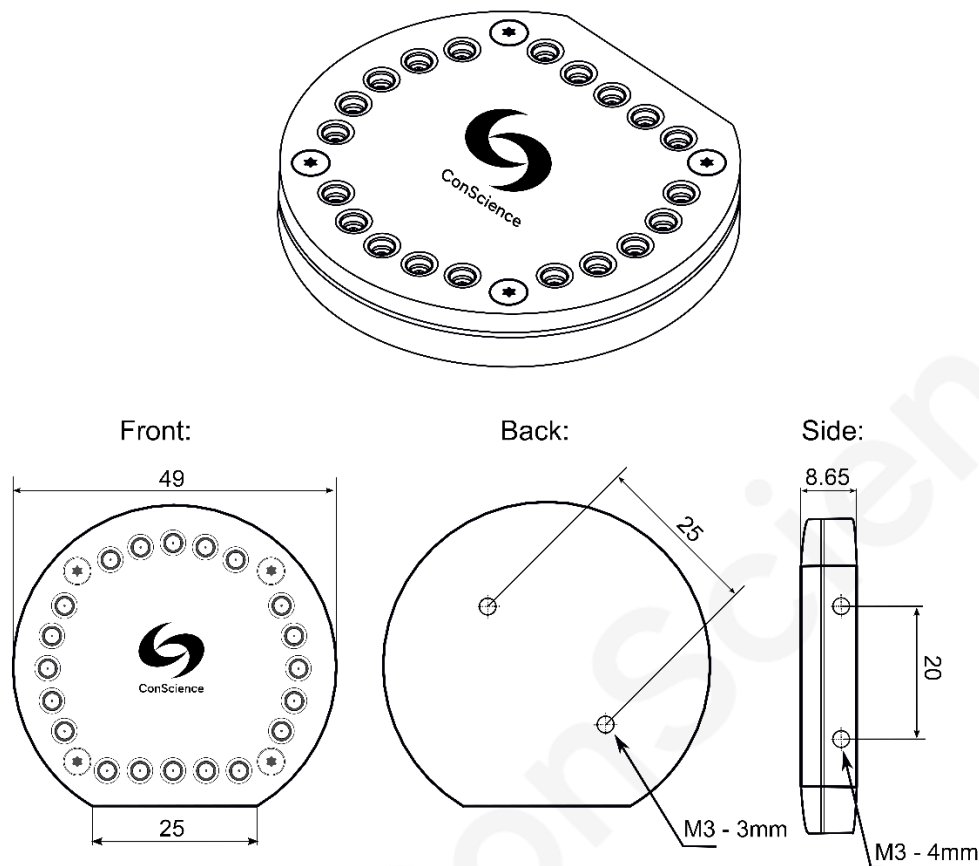
Port ID	Box20 Input/output line connection	
	Line type	Target element
1	–	–
2	–	–
3	Drive	Q4
4	Drive	Q5
5	–	–
6	Readout I/O*	All
7	–	–
8	–	–
9	–	–
10	Readout I/O*	All
11	–	–
12	Drive	Q2
13	Flux	Q3
14	–	–
15	–	–
16	Drive	Q3
17	–	–
18	–	–
19	–	–
20	Flux	Q4



*The on-chip readout input/output transmission line is reciprocal; therefore, ports 7 and 10 are interchangeable - either may connect to the cryostat's readout input line, with the remaining port connecting to an output line.

Dimensions

Units: mm



Dual-use

The device is classified as dual-use (can be used for both civilian and military applications) according to Annex 1, Category 3: Electronics, 3A001 **:

Electronic devices and circuits containing components, manufactured from "superconductive" materials, specially designed for operation at temperatures below the "critical temperature" of at least one of the "superconductive" constituents and having any of the following:

1. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10-14 J; or
2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10 000;

** Specific export regulations may apply depending on destination country.