

# QRM-RF / 2-18.5 GHz Qubit Readout Module | Cluster Series 19" Rack Mounted

Release November 2021\_V1.4

## Description

The QRM-RF combines all the multiplexed sequencing power of the qubit control module with internal downconversion stages to directly input and output signals over a wide frequency range from 2 GHz up to 18.5 GHz. Combining inputs and outputs in one module makes reflectometry/transmission readout schemes convenient as the readout pulse and acquisition can be triggered from the same sequence processor and use the same LO for guaranteed phase stability.

The module is made for frequency-multiplexed readout of up to 6 frequencies over a wide band of 750 MHz without compromising on its state-of-the-art spurious-free dynamic range of 55 dB (typical). With its internal calibration capabilities, it removes the need for any external mixer calibration equipment and inconvenient disconnections from the experiment.

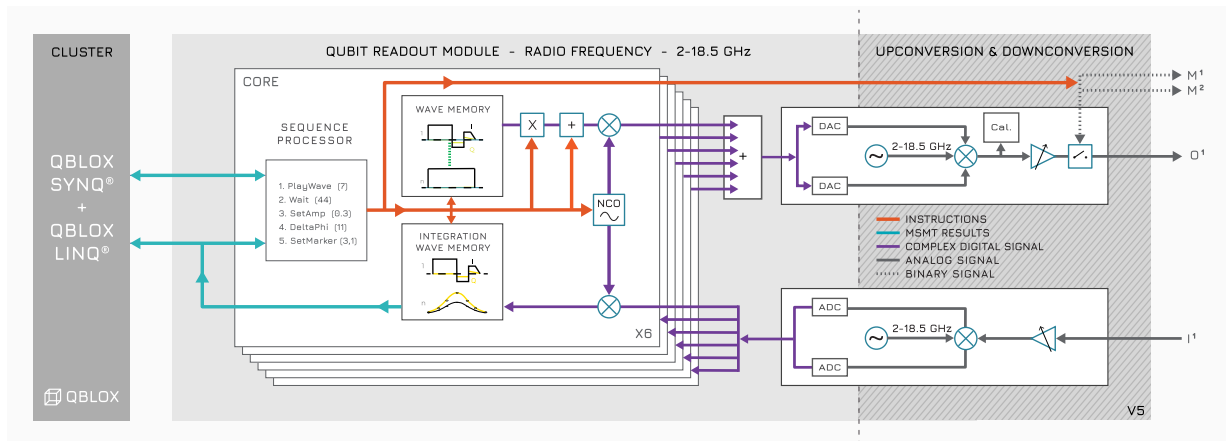
Measurements on up to 6 qubits can be multiplexed, however, their timing is completely independent, allowing arbitrary scheduling of measurement operations. Arbitrary pulse shapes and arbitrary complex integration functions can be uploaded to suppress crosstalk and optimize measurement efficiency under dynamic readout conditions.

Up to 131.072 IQ shots can be stored. Onboard averaging (and binning) can be used to reduce data transfer overhead for averaged experiments.



## Features

- Real-time control of amplitude offset and modulation phase.
- Multiplexed readout of up to 6 frequencies.
- Synchronized to all other modules via SYNQ protocol.
- On-board integration and state assignment. Measurement outcomes are shared with all other modules via LINQ within 200 ns.
- Long pulse and integration times can be achieved by constructing them from sequencer instructions (for instance for spectroscopy).
- On-board averaging and binning of measurement results with up to 131.072 IQ bins
- Integrated calibration protocols for up and downconversion stages.
- External instrument triggering via 2 marker outputs.



## Specifications QRM-RF

Frequency Range (-3 dB)	2 - 18.5 GHz	Frequency resolution (Input and Output)	0.25 Hz (IF), 1 Hz (LO)
Analog output/input channels	1/1	Measurement result memory (IQ shots)	131.072 (48 bit wide)
Analog bandwidth (-3dB)	750 MHz	Ethernet data rate	1 Gbit/s
DAC/ADC sample rate	1 GS/s (for I and Q)	Driver/API	SCPI / Python / QCoDeS
DAC/ADC resolution (vertical)	12 bit (for I and Q)	Max. power consumption (via Cluster)	48 W
Binary output markers	2 (3.3V LVTTTL)	Input/Output connector type	SMA
Max. Output power (into 50 Ω)	-40 to +5 dBm (settable)	Marker connector type	SMP
Spurious-free dynamic range	55 dB (typical)	Dimensions single module	269 x 130 x 20 mm <sup>3</sup>
Phase noise (@3 GHz, 10 kHz offset)	-115 dBc/Hz	Weight	0.322 kg
Max. input power (into 50 Ω)	-26 to 0 dBm (settable)		