Quartz Crystal Microbalances

QCM100 and QCM200 — 5 MHz quartz crystal microbalances

Quartz Crystal Microbalance

- **Frequency and resistance display (QCM200)**
- **Analog output for potentiostats**
- **Reads highly loaded crystals (up to 5 kΩ)**
- **Transformer-isolated crystal for EQCM measurements**
- **Simple shunt-capacitance cancellation**
- **No network/impedance analysis necessary**

- **QCM100 ... $995** *(U.S. list)*
- **QCM200 ... $2495** *(U.S. list)*

The QCM100 and QCM200 are accurate quartz crystal microbalance systems designed for real-time mass and viscosity measurements in processes occurring at or near surfaces, or within thin films.

The QCM series measure the resonant frequency and resistance of an AT-cut quartz crystal. The resonant frequency changes as a linear function of the mass of material deposited on the crystal surface. The resistance at resonance changes with the viscoelasticity of the material (film or liquid) in contact with the crystal's face.

As a gravimetric instrument, the QCM100 or QCM200 can measure mass ranging from micrograms to fractions of a nanogram, with detection limits corresponding to submonolayers of atoms. Measurement of resistance provides the opportunity to examine the viscosity and elasticity of films and liquids at or near the crystal surface. This makes it feasible to observe conformational changes such as phase transitions, swelling and cross-linking, in real time. The electronics are specifically designed to handle heavy loads (up to 5 kΩ) making these instruments ideal for studies involving lossy films and highly viscous liquids.

QCM200

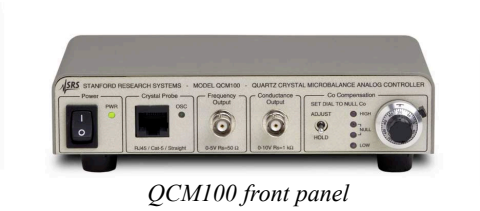
The QCM200 is a stand-alone instrument with a built-in frequency counter and resistance meter. It includes controller, oscillator electronics, crystal holder, and three quartz crystals. Series resonance frequency and resistance are measured and

QCM200 front panel

displayed, and there is an analog output proportional to frequency which can be used to interface with potentiostats. In addition, the QCM200 has an RS-232 interface and comes with both Windows and MacIntosh software which provides a real-time analysis of your samples. Both frequency and resistance trends can be viewed. User-tags are provided to time-stamp important events.

QCM100

The QCM100 comes with controller, oscillator electronics, crystal holder, and three quartz crystals, but requires an



QCM100 front panel

external frequency counter and precision voltmeter to complete the QCM measurement setup.

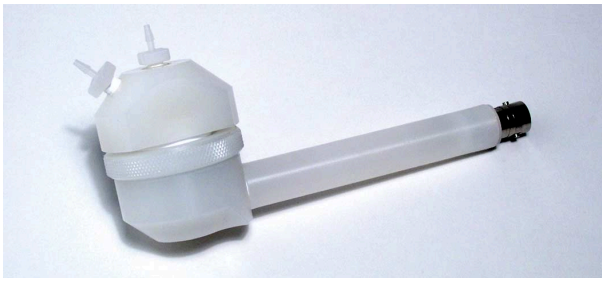
Crystal Oscillator Electronics

The crystal oscillator electronics employ a unique automatic gain control (AGC) circuit instead of the traditional phase-lock oscillator (PLO). The AGC provides the quartz crystal resonator with the necessary gain to overcome viscoelastic losses and achieve series resonance. It also provides a signal for monitoring the energy dissipated by the sensor (which is related to the series resonance resistance). The oscillator will reliably drive crystals with resistance up to 5 kΩ, and will maintain oscillation in viscous aqueous solutions containing over 88 % glycerol (w/w %).

The controller for each instrument provides power to the crystal oscillator electronics and includes a potentiometer for canceling shunt capacitance. Proper capacitance cancellation is required to assure true series resonance operation of the crystal oscillator and to eliminate frequency and resistance errors.

Flow Cell

An axial flow cell adapter (opt.) is available which attaches to the standard crystal holder. This provides the simplest way to interface a QCM to a flow injection analysis system.



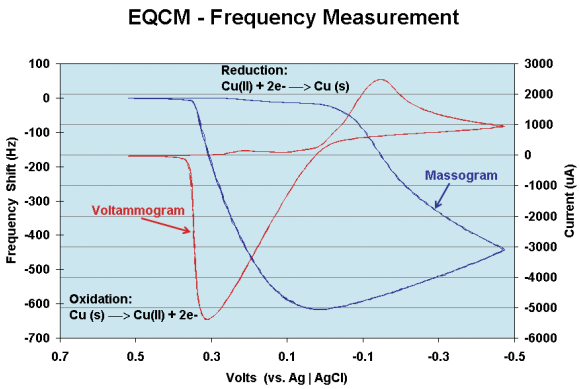
Quartz Crystals

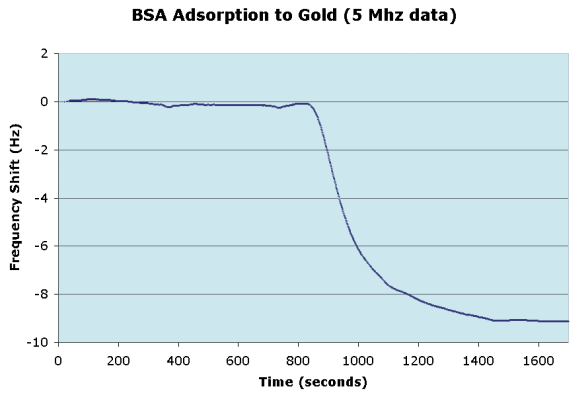
The QCM100 and QCM200 use a 5 MHz, 1" diameter, AT-cut quartz crystal. All crystals are designed for operation in liquids and are available in a variety of materials.

EQCM

The crystal holder is designed so that only the front electrode is exposed to the gas or liquid under test, as required in EQCM experiments. A conductive metallic pad (wrap-around electrode) allows connection to the front electrode from the back of the crystal. This feature, combined with an analog frequency output and transformer isolation between the crystal electrodes and the oscillator circuit, makes the QCM100 and QCM200 compatible with virtually all potentiostats.

Oscillator electronics, crystals and holder

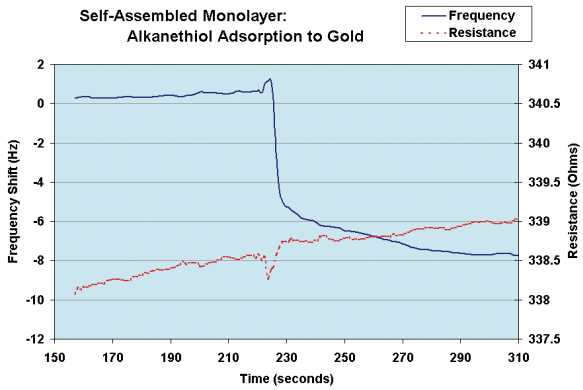




In the Lab

The QCM100 and QCM200 are valuable research tools for applications ranging from pure surface science to electrochemistry. Frequency, mass and resistance measurements can be made in both gas and liquid phase environments. Quartz crystals can be pre-coated with any thin film material including organic polymers, hydrogels, composites, ceramics, biomolecules, bacteria and living cells. This provides unlimited potential for the development of novel gas and biological sensors.

A QCM100 or QCM200 Quartz Crystal Microbalance is an essential addition to any biological laboratory. The data from a QCM perfectly complements that obtained from other techniques such as surface plasmon resonance (SPR) and atomic force microscopy (AFM), aiding the analysis of complex biological interactions.



Applications

Immunosensors
Sorption sensors
Moisture analyzers
Particulate monitors
Contamination monitors
Electrovalency measurements
Hydrogen absorption on metal films
Bubble formation
Redox and conductive polymer research
Double-layer characterization
Corrosion studies
Surface oxidation
DNA and RNA hybridization studies
Antigen-antibody reactions
Protein adsorption
Detection of virus capsids, bacteria, mammalian cells
Biofouling and antifouling
Biomembranes and biomaterials
Cell adhesion
Protein-protein interactions
Self-assembled monolayers (SAMs)
Molecularly imprinted polymers (MIPs)
Langmuir/Langmuir-Blodgett films
Laser ablation, desorption and breakdown studies
MEMs nanomaterials
Intelligent biomaterials

QCM100 rear panel

QCM200 rear panel

QCM200

Frequency Measurement

Frequency display	
Resolution	0.01 Hz (10 second gate)
Gate time	0.1 s, 1 s, 10 s, user-selectable
Analog output	
Δf output	±10 V full scale (20-bit)
Ranges	±200 kHz, ±100 kHz, ±50 kHz, ±20 kHz, ±10 kHz, ±5 kHz, ±2 kHz
Frequency output	
Frequency	5 MHz (nominal)
Level	TTL (square wave)
Source impedance	50 Ω
Connector	BNC

Resistance Measurement

Resistance display	
Range	0 to 5000 Ω
Resolution	5 digits: 0.001 Ω for R < 100 Ω 0.01 Ω for 100 Ω ≤ R < 1000 Ω 0.1 Ω for 1000 Ω ≤ R < 5000 Ω
Conductance output (Vc)	
Resistance	$R = 10{,}000 \times (10^{-Vc/5}) - 75\ \Omega$
Resistance range	0 to 5000 Ω
Voltage level	0 to 10.625 VDC, log scale
Impedance	1 kΩ
Connector	BNC

Capacitance Cancellation

Range	10 to 40 pF (20 pF nominal)
Limit	0.01 pF

Physical

Interface	RS-232, 9600 baud, no parity, no flow control
Dimensions	10.625" × 2" × 7" (WHD)
Weight	2 lbs.
Operating temperature	0 °C to 40 °C
Power	15 W, 100/120/220/240 VAC, 50/60 Hz

Quartz Crystals (polished)

Frequency	5 MHz, AT-cut, plano-plano
Diameter	1 inch
Electrodes	Chromium/gold (titanium/gold, titanium/platinum, indium tin oxide are optional)

Crystal Holder

Material	Kynar®
O-ring	Viton®
Connector	BNC

QCM100

Frequency Measurement

Frequency	5 MHz (nominal)
Level	TTL (square wave)
Source impedance	50 Ω
Connector	BNC

Conductance Output (Vc)

Resistance	$R = 10{,}000 \times (10^{-Vc/5}) - 75\ \Omega$
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Crystal Holder

Material	Kynar®
O-ring	Viton®
Connector	BNC

Ordering Information

QCM100	Controller, oscillator, 3 crystals and holder (requires counter & DVM)	$995
QCM200	Controller, oscillator, 3 crystals, holder and software	$2495
O100FC	Axial flow cell	$295
O100RXO	Replacement oscillator module	$395
O100RH	Replacement holder (Kynar®)	$395
O100RX1	Chrome/gold crystals (qty. 10)	$295
O100RX2	Indium tin oxide crystals (qty. 10)	$595
O100RX3	Titanium/gold crystals (qty. 10)	$295
O100RX4	Titanium/platinum crystals (qty. 10)	$395