Quartz Crystal Microbalances

QCM100 and QCM200 — 5 MHz quartz crystal microbalances

QCM200 Quartz Crystal Microbalance

Quartz Crystal Microbalance

- ***Measures frequency and resistance***
- ***Analog output for potentiostats (QCM200)***
- ***Reads highly loaded crystals (up to 5 kΩ)***
- ***Transformer-isolated crystal***
- ***Simple shunt-capacitance cancellation***
- ***External 10 MHz input (QCM200)***
- ***Windows/Mac software (QCM200)***

- ***QCM100 ... $1295*** *(U.S. list)*
- ***QCM200 ... $2495*** *(U.S. list)*

The QCM200 and QCM100 Quartz Crystal Microbalances measure mass and viscosity in processes occurring at or near surfaces, or within thin films. These systems include a controller, crystal oscillator electronics, crystal holder, three quartz crystals, and Windows / Mac software (QCM200).

The instruments read the resonant frequency and resistance of a 5 MHz, 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 viscosity / elasticity of the material (film or liquid) in contact with the crystal surface.

As gravimetric instruments, the QCM200 and QCM100 can measure mass ranging from micrograms to fractions of a nanogram. Detection limits correspond to submonolayers of atoms. Observations of conformational changes, such as phase transitions, swelling, and cross-linking, can easily be made.

Specifically designed to handle heavy loads (up to 5 kΩ), the instruments will maintain oscillation in aqueous solutions containing over 88 % glycerol (w/w %). They are 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. Series resonance frequency and resistance are measured and displayed, and there is an analog output proportional to frequency which can

QCM200 front panel

be used to interface with a potentiostat. The QCM200 can be operated from the front panel or a PC using the RS-232 interface. Windows and MacIntosh software is provided for real-time data acquisition, display, analysis and storage. Both frequency and resistance trends can be viewed. User-tags are provided to time-stamp important events.

The stability and accuracy of the QCM200 are ideal for most experiments. For special applications requiring optimum long-term frequency stability, a precision timebase, such as the FS725 Rubidium Frequency Standard, can be connected to the external 10 MHz input.

QCM100

The QCM100 is a basic quartz crystal microbalance which has the same measurement capabilities as the QCM200, but requires connection to an external frequency counter and

QCM100 front panel

precision voltmeter (which are not included) to complete the QCM measurement setup.

QCM Electronics

A unique automatic gain control circuit provides the quartz crystal with the required signal amplitude to overcome viscoelastic losses and achieve series resonance. It also monitors the energy dissipated by the sensor, which is used to determine the series resistance of the crystal. The controller 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.

In the QCM200, the digital controller also contains a frequency counter with 0.01 Hz resolution for accurate frequency measurements, and a resistance meter with 5 digits of resolution covering a range of 0 to 5000 Ω.

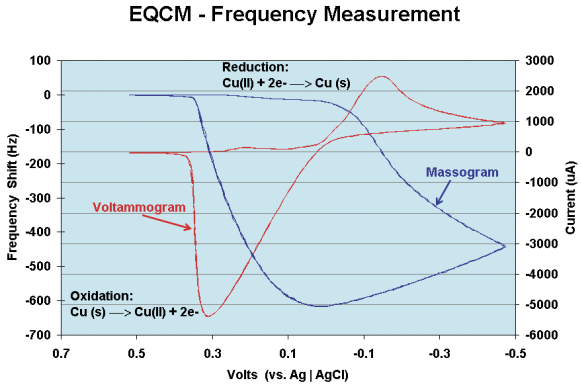
Crystals, Holder and Flow Cell

The QCM200 and QCM100 use a 5 MHz, 1" diameter, AT-cut quartz crystal wafer with circular electrodes on both sides. Crystals are available in a variety of materials. The crystal holder is a rugged, compact, easy to use fixture. The holder and all crystals may be used in liquid or gas environments.

An optional axial flow cell adapter attaches to the standard crystal holder. This provides an easy way of interfacing the QCM to a flow injection analysis system.

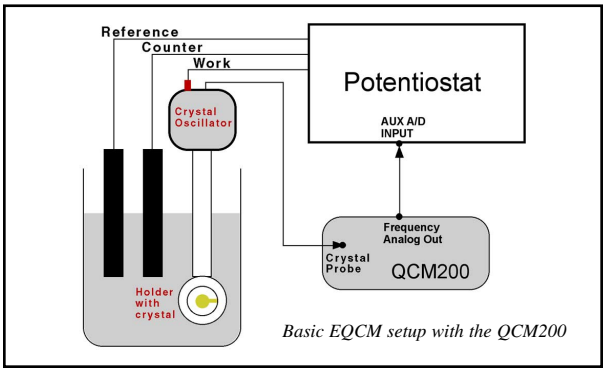
EQCM (QCM200)

For EQCM applications, an analog output proportional to frequency shift may be directly connected to a potentiostat or

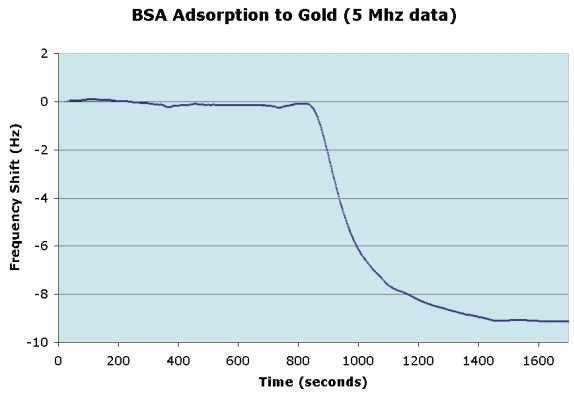


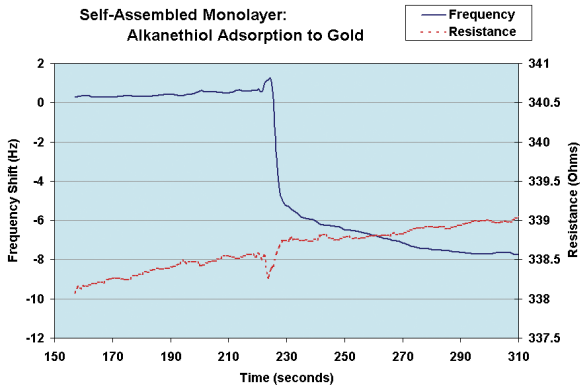
galvanostat. Only the front-surface electrode of the crystal is exposed to the solution. This electrode is also transformer isolated, as required for EQCM operation.

The figure below illustrates a typical EQCM experiment. The frequency analog output of the QCM controller is connected



Basic EQCM setup with the QCM200



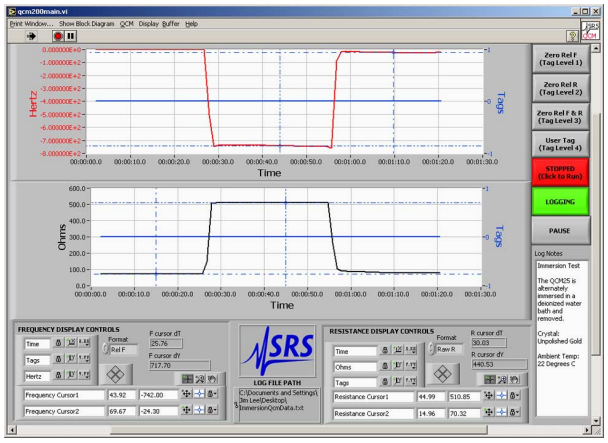


to the potentiostat A/D input. The potentiostat digitizes the voltage, and it's software displays relative frequency changes synchronous with the electrochemical data. The versatile QCM200 can be easily integrated into any custom 5 MHz crystal based EQCM setup.

In the Lab

The QCM200 and QCM100 are valuable research tools for applications ranging from pure surface science to biochemistry. 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.

These quartz crystal microbalances are 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 in the analysis of complex biological interactions.



QCM200 Software

A Windows/Mac software program is included (QCM200) to facilitate remote operation and simplify data acquisition.

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
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) 0.1 Hz (1 second gate) 1.0 Hz (0.1 second gate)
Gate time	0.1 s, 1 s, 10 s, user-selectable
Measurement (internal timebase)	
Stability	$<2\times10^{-9}$ Allan Variance (typ.)
Accuracy	±1.5 ppm
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
Ext. timebase input	
Frequency	10 MHz
Level	1 Vpp (nominal)

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

Capacitance Cancellation

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

Physical

Analog connectors	BNC
Interface	RS-232, 9600 baud
Crystal holder	
Material	Holder: Kynar®, O-ring: Viton®
Cable type, length	Cat-5, 3 ft.
Dimensions, weight	10.6"×2"×7" (WHD), 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	Cr/Au (Ti/Au, Ti/Pt, In Sn oxide opt.)

QCM100

Frequency Measurement

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

Capacitance Cancellation

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

Quartz Crystals (polished)

Frequency	5 MHz, AT-cut, plano-plano
Diameter	1 inch
Electrodes	Cr/Au (Ti/Au, Ti/Pt, In Sn oxide opt.)

Physical

Analog connectors	BNC
Crystal holder	
Material	Holder: Kynar®, O-ring: Viton®
Cable type, length	Cat-5, 3 ft.
Dimensions, weight	7.1"×2"×5.4" (WHD), 1 lbs.
Operating temperature	0 °C to 40 °C
Power	10 W, 100/120/220/240 VAC, 50/60 Hz

Ordering Information

QCM100	Controller, oscillator, 3 crystals and holder (requires counter & DVM)	$1295
QCM200	Controller, oscillator, 3 crystals, holder and software	$2495
O100FC	Axial flow cell	$295
O100RXO	Replacement oscillator module	$395
O100RH	Replacement holder (Kynar®)	$395
O100CCB	Crystal cleaning basket	$195
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