



ELCHEMA

**P.O. Box 5067
Potsdam, New York 13676**

Tel.: (315) 268-1605

FAX: (315) 268-1709

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1. INTRODUCTION

The Model EQCN-700 Electrochemical Quartz Crystal Nanobalance is a measurement system for monitoring extremely small variation in the mass of a metal working electrode. The EQCN-700 System consists of a Model EQCN-700 Nanobalance Instrument, Model EQCN-700-2 Faraday Cage, and Model EQCN-700-3 Remote Probe Unit.

The material of the working electrode is gold, unless otherwise ordered. The working electrode is in the form of a thin film, and is placed on one side of a quartz single crystal wafer which is sealed to the side opening in an electrochemical cell. The AT-cut quartz crystal oscillates in the shear mode at nominal 10 MHz frequency. Any change in the mass rigidly attached to the working electrode results in the change of the quartz crystal oscillation frequency. The frequency of the working quartz crystal is compared to the frequency of the standard reference quartz crystal. The frequency measurements are differential, i.e. the frequency of the reference crystal is subtracted from the frequency of the working crystal. The obtained frequency difference is then measured by a precision frequency counter and displayed on the front panel. The frequency difference is converted to a voltage signal, calibrated in Sauerbrey mass units (referred to as the effective mass) and output to an analog recorder, or analog-to-digital converter.

Typical processes leading to the frequency change which corresponds to the effective mass change at the working electrode are listed below:

- adsorption/desorption
- metal/alloy plating
- surface oxidation
- corrosion and corrosion protection
- etching
- heterogeneous polymerization
- ion ingress to (or egress from) ion exchange films
- oxidation/reduction of conductive polymer films
- intercalation
- coadsorption and competitive adsorption
- moisture accumulation (from gaseous phase)
- etc.

With the Model EQCN-700 you can monitor time transients of the effective electrode mass in an electrochemical or non-electrochemical cell, filled with liquid or gas. You can also perform voltammetric experiments of any type, and monitor potential or current dependence of the effective electrode mass.

The digital resolution of the EQCN-700 is 0.1 Hz which corresponds approximately to 0.1 ng of the effective mass change. The analog resolution is 0.01 ng (100 ng range). The short-term stability is mostly dependent on the state of the working electrode surface, purity of the solution, and temperature variations. Usually, it is better than 1-5 Hz. The exceptional linearity of mass measurements extends up to 100 μ g. The use of AT-cut quartz crystals reduces temperature coefficient to the minimum. Under normal circumstances, the effect of temperature can be neglected in the range near the room temperature. If a very high sensitivity or wide temperature range are required, it is recommended to use a thermostatted cell and Model EQCN-700-3B Remote Probe Unit with thermostatted reference oscillator, or Model EQCN-700-4 Remote Probe Unit with external reference quartz crystal.

The Model EQCN-700 has a built-in frequency reference (10.000 MHz) for the determination of frequency shift Δf . Since the best measurement conditions in terms of speed and stability are for frequency shifts larger than 10 kHz and the working crystal frequency may vary due to the mass added or removed from the crystal electrode surface, the Model EQCN-700 is now equipped with an external frequency reference input. So, you can connect an external frequency source, *e.g.* our Model FG-806 high stability reference frequency generator, to adjust reference frequency in a wide range from 9.95 to 10.05 MHz with a step of 1 kHz.

To perform electrochemical measurements, a potentiostat may be required. We offer a line of potentiostats specially designed to work with oscillating quartz crystal electrodes. The Model PS-205 is a general purpose potentiostat/galvanostat with potential control from -8 to +8 V. The Model PS-305 is a precision potentiostat/galvanostat, and Models PS-505 and PS-605 offer exceptionally low noise and high precision, as well as an extended potential range control (-10 to +10 V).

For computer controlled measurements, we recommend a Data Logger DAQ-716v with Real-Time VOLTSCAN Data Acquisition and Control System (based on a 16-bit D/A converter and 16-bit A/D converters). Further data processing, graphing and spreadsheet reporting can be done with any spreadsheet and graphics package, such as the MS EXCEL, Microcal ORIGIN, etc.

2. SPECIFICATIONS

Frequency Shift Measurements

Frequency Shift Digital Display Type	LCD
Number of Digits	6
Resolution	0.1 Hz
Measurement Accuracy	0.0001 % ∇ 1 digit
Frequency Shift Range (digital)	0 to 500 kHz
Analog Meter Type	LCD
Number of Digits	4.5
Resolution	0.01 Hz
Accuracy	0.02 % of reading + 0.2 % FS
Frequency Shift Ranges (analog)	<i>F</i> mode

RANGE:

100 kHz
10 kHz
1 kHz
0.1 kHz

READINGS:

-100.0 to +100.0 kHz,
-10.00 to +10.00 kHz,
-1.000 to +1.000 kHz,
-100.0 to +100.0 Hz

Mass Change Measurements

Analog Meter Type	LCD
Number of Digits	4.5
Resolution	0.01 ng
Accuracy	0.02 % of reading + 0.2 % FS
Mass Change Ranges (analog)	<i>M</i> mode

RANGE:

100 μ g
10 μ g
1 μ g
0.1 μ g

READINGS:

-100.0 to +100.0 μ g,
-10.00 to +10.00 μ g,
-1.000 to +1.000 μ g,
-100.0 to +100.0 ng

Extended linearity	10 % over nominal range
Overload Indicator	ca. 2 % over nominal range

Recorder Output

Analog Output Voltage (<i>V-OUT</i>)	-10 to +10 V
Extended linearity	10 % over nominal range
Voltage to Mass Change Ratio	10 V per nominal range (<i>M</i> mode)

Voltage to Frequency Shift Ratio	10 V per nominal range (<i>F</i> mode)
Output Voltage Accuracy	0.005 % of reading + 0.01 % FS
Offset Voltage: coarse	90 μ g (approx.)
fine	800 ng (approx.)
Frequency Shift (<i>F-OUT</i>)	square wave, 0 and +5 V levels
Logic compatibility	TTL/CMOS compatible
Rise Time	40 ns

Operating Parameters

Reference Crystal Frequency	10.000 MHz
Power Supply	110/220 V, 50 - 60 Hz
Dimensions: Instrument	4H x 17W x 16.5D, inch
Faraday Cage	16H x 12W x 11D, inch

EQCN-700 System Components

Model EQCN-700	Electrochemical Nanobalance Instrument
Model EQCN-700-2	Faraday Cage
Model EQCN-700-3	Remote Probe Unit (mounted on the back of the Faraday Cage)

Options

EQCN-700-3B	Remote Probe Unit with Thermostatted Reference Oscillator
EQCN-700-4	Remote Probe Unit with External Reference Crystal
RTC-100	ROTACELL Electrochemical Cell System with Piezocell
DAQ-716 vu	Data Logger with VOLTSCAN Real-Time Data Acquisition and Control System (includes 16-bit D/A Converter, 16-bit A/D Converters, VOLTSCAN software with waveform generation, Break-Up Box, CPU, MS Windows O.S.)
PS-205B	General Purpose Potentiostat/Galvanostat
PS-605	Precision Potentiostat/Galvanostat (0.3 A max, 0.1 pA resolution, 300 ns rise time, ± 15 V)
FG-299	Frequency Meter/Calibrator/Generator
Electrodes	Wide selection of quartz crystal working electrodes with Ag, Au, Al, Co, Cr, Cu, Fe, Ni, Pt, and Zn coatings

3. OPERATING INSTRUCTIONS

3.1. INSPECTION

After the instrument is unpacked, the instrument should be carefully inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in the "Claim for Damage in Shipment" section at the end of this Manual.

3.2. PRECAUTIONS

Care should be taken when making any connections to the instrument. Use the guidelines for maximum voltage at the inputs. There should be no signal applied to the inputs when the instrument is turned off. The outputs should not be loaded. They can only be connected to high input impedance devices such as plotters or oscilloscopes.

Use minimal force when putting on, or taking off, the BNC connections, otherwise they might become loose. Push the BNC forward when making a connection or a disconnection in order to relieve the rotational tension on the BNC socket.

Observe the color codes when connecting the power to the probe unit.

Operate the instrument in a cool and well ventilated environment.

Contact us in the event that any of our components do not operate properly. Our components are marked with seals. **DO NOT** try to open and fix anything yourself, otherwise your warranty agreement will be **nullified**.

3.3. FARADAY CAGE

The Faraday cage tips over easily. It is also possible for someone to accidentally brush against it and break, or spill the contents of the cell inside. Hence, it is advised to secure the Faraday cage by mounting an L-shaped bracket in the back of it.

3.4. GROUNDING AND INTERFERENCES

It is very important to properly ground the Nanobalance system. The circuitry operates at a high frequency of 10 MHz and is very susceptible to electromagnetic radiation and interference present in the surroundings. Since the working oscillator can not be enclosed in a case due the nature of measurements, the use of a Faraday cage is necessary. Usually, the door of the Faraday cage does not need to be completely closed. (Do not lock the door unless you see an improvement in shielding efficiency and temperature stability of the crystal frequency.). If you find that in your application leaving the door of the Faraday cage wide open does not result in any external influences on the frequency reading, you may wish to remove the door to save space on the bench. Normally, Faraday cage does not need to be grounded with additional wires. You can connect the Faraday cage chassis to the AC ground or water pipe using a thick grounding cable, if necessary. Make this connection only if you see an improvement in shielding or reduction in noise. Avoid creating ground loops! The Nanobalance Instrument (EQCN-700) is connected to the AC ground through the HP type 3-conductor power cable. With the short banana-to-banana cable (provided), connect the chassis of your potentiostat to the chassis of the Nanobalance Instrument EQCN-700 using the CHASSIS banana socket (metal hex nut) on the back panel of the EQCN-700. You can also use this socket for reference purposes or to connect to other instruments which need to be grounded. The analog ground of the EQCN-700 is provided on the back panel (black banana socket marked GND) for reference purposes. Normally, do not connect anything to this socket. However, you can short it to the AC ground (CHASSIS) or to the analog ground of the potentiostat if necessary. Remove all unnecessary cables from the instrument before doing measurements. (Cables which are not connected on the other end may act as antennas and should also be removed. Note that some measurement instruments, e.g. oscilloscopes, have often the cable guard shorted to the AC ground. Making a connection to such an instrument is equivalent to shorting the analog ground of Nanobalance Instrument to the AC ground.).

Since the oscillating circuit is connected to the electrochemical cell through the working electrode, changes in position of wires connected to the Reference and

Counter Electrodes with respect to ground planes may result in some frequency change due to the change in parasitic capacitance. Make sure that all electrodes are firmly attached to the cell top and the connecting wires are short and do not bounce during the measurements. The connections between the working quartz crystal and the Remote Probe Unit (blue and white tip banana jacks) should be as short as possible and the interwire capacitance should be kept constant during the measurements.

In microelectrogravimetric technique, we do not measure the absolute mass of the working electrode but rather the mass change that occurs during the experiment. At the beginning of the experiment, you set the initial mass to zero (or any other value you wish) using the MASS OFFSET potentiometers located on the front panel of the instrument. Due to the high sensitivity of measurements (compare it with a regular balance), it is essential that you maintain all the system parameters (including parasitic capacitances of connecting wires and cables) constant. Only then the frequency change observed during the experiment will correspond to the change in values of parameters of the equivalent circuit of the quartz crystal assembly (especially the inductance change proportional to the change in mass rigidly attached to the working electrode).

With electrochemical cells, a significant frequency change (observed as a drift) may occur even at constant potential due to surface changes, adsorption, poisoning, etc. Use only high purity chemicals. Please keep in mind that the gold substrate may undergo slow dissolution at higher potentials which may lead to the apparent mass decrease (absolute frequency increase). Very often mass changes may result as a consequence of the surface oxide formation. Sudden metal dissolution may result in oversaturation and deposition of salts on the electrode surface. Deposits on the surface may be sometimes difficult to remove and may block the surface and change the electrode activity. If you are not familiar with electrochemistry at solid electrodes, consult general textbooks and monographies (e.g., A. J. Bard and L. R. Faulkner, *Electrochemical Methods*, J. Wiley and Sons, New York, 1980).

WARNING: Do not attach ground wires to a gas or heating pipe.

3.5. THERMAL SENSITIVITY

As with any electronic equipment, this instrument should be warmed up in order to achieve the greatest accuracy. Under normal circumstances, the frequency difference readout on the front panel of the instrument should be stable to 1-2 Hz after 15 minute warmup and the analog mass change readout should stabilize in 30 minutes.

4. INSTALLATION

The operating instructions have been made short and simple but make sure they are followed in this exact order. **Bold** letters indicate connections and controls on the instrument only.

4.1. Initial set-up

- (1) Unpacking.
Carefully remove all paper and tape used in shipping. Place instrument on a convenient bench. Check the items against the packing list.
- (2) The Faraday Cage (EQCN-700-2) should be placed on the left side of the Nanobalance Instrument (EQCN-700) to have connections as short as possible.
- (3) This instrument has been set for 110 V a.c., 50-60 Hz, power supply when shipped within the USA and Japan, or 220 V a.c., 50-60 Hz, when shipped elsewhere. If necessary, you can change this setting by changing the position of the supply voltage selector 110/220 located on the back panel of the instrument. If you have to make the change, make sure the power in the instrument, **AC**, and in all other devices is off, and nothing is connected to the instrument or the probe unit. With the power cord *disconnected* from the instrument, set the power supply voltage switch to the appropriate position, 110 or 220 V. Connect the power cord back to the instrument.
- (4) Connect the **PROBE** BNC sockets on the back panel of the Nanobalance Instrument (EQCN-700) labeled **1**, **2**, and **3** to BNC sockets with the corresponding numbers on the side panel of the

Remote Probe Unit which is mounted on the back of the Faraday Cage, using the coaxial cables provided.

- (5) Connect the multiconductor cable with 6-pin audio-type connectors to the sockets marked **SPLY** (SUPPLY) on the back panel of the instrument and on the side panel of the Remote Probe Unit.
- (6) Put the **FREQUENCY SENSITIVITY** switch to 'x 1' position.
- (7) Put the **M/F** mode switch to the **M** position for frequency difference conversion to the Sauerbrey mass change.
- (8) Put the **RANGE** selector to **100 _g** position (least sensitive).
- (9) Put the **OFFSET ON/OFF** switch to the **OFF** position.
- (10) Put the mass change **POLARITY** (+/-) switch to the + (plus) position.
- (11) Connect the **RECORDER V-OUT** BNC output socket to the input of the recorder (you can use a strip chart recorder, X-Y recorder, or a computerized data logger, *e.g.* VOLTSCAN Real-Time Data Acquisition and Control System available from ELCHEMA).
- (12) Zero the recorder.
- (13) Set the range on the recorder to 10 V.

4.2. Power ON checks

- (1) Turn the power switch **ON**.
- (2) Set the **DAMPING** selector to the first position.
- (3) Insert a 10 MHz quartz crystal (*e.g.* ELCHEMA Cat. # QC-10-Au) in the Crystal-Cell assembly (ROTACELL, Model RTC-100). Connect pin tip plugs from the Crystal-Cell assembly to the white and blue pin tip jacks **CRYSTAL**, inside the Faraday Cage. These jacks are labeled **AIR** and **LIQUID** for electrodes on the quartz crystal exposed to the air and solution, respectively. (For Crystal-Cell assembly instructions refer to Chapter 5.)
- (4) At this point, the frequency meter should give you some frequency difference reading. Typical values are from 500 Hz to 90 kHz. If the reading is 0, the contacts to the working crystal may not be good or crystal cannot oscillate due to a strong damping (thick film deposited on the crystal, broken crystal, *etc.*).
- (5) Note the voltage at the output. The recorder output voltage is 10 V per nominal mass range (FS).
- (6) Set the **OFFSET ON/OFF** toggle to the **ON** position.
- (7) Use the **COARSE** and **FINE OFFSET** knobs to set the MASS display and the recorder output voltage to zero (or close to zero). The recorder output voltage provided at the V-OUT BNC jack is 10 V FS (full scale) for the nominal mass (or frequency) RANGE.
- (8) You can now change the **MASS RANGE** to more sensitive one. Again, use the **COARSE** and **FINE OFFSET** knobs to set the mass reading on MASS panel meter to zero.
- (9) Repeat the operations (7-8) until the **MASS RANGE** with desired sensitivity is selected.
- (10) In the following testing, observe the rules:
 - Start experiments with *MASS change* set to *zero* (or close to zero).
 - Before removing the Working Crystal from the ROTACELL fixture, change the mass RANGE to 100 _g.

4.3. Connections to a potentiostat

- (1) Make sure, the potentiostat CELL switch is set to OFF, or a DUMMY CELL position.
- (2) Connect the working electrode socket on your potentiostat to the BNC socket **WE** on the back panel of the Nanobalance Instrument. (Do not connect the working electrode socket on your potentiostat directly to the *Working Electrode*.)
- (3) Connect the counter (or: auxilliary) electrode socket on your potentiostat to the BNC jack **CE** on the back panel of the instrument. (Do not connect the counter electrode socket on potentiostat directly to the *Counter Electrode*.)
- (4) Connect the reference electrode socket on your potentiostat to the BNC socket **REF** on the side panel of the Remote Probe Unit. (Do not connect the reference electrode socket on potentiostat directly to the *Reference Electrode*.)
- (5) Connect the *Counter Electrode* in the electrochemical cell to the red pin tip jack **CE** inside the Faraday Cage.
- (6) Connect the *Reference Electrode* in the electrochemical cell to the orange pin tip jack **REF** inside the Faraday Cage.
- (7) Make sure the *working crystal* is connected to the white and blue pin tip jacks marked **CRYSTAL**, **Air** and **Liquid**, respectively, inside the Faraday Cage. (For Crystal-Cell assembly instructions refer to Chapter 5.)
- (8) You are now ready to start your experiment. Refer to the next section to learn the details of the experimental procedure illustrated with an example of the deposition and stripping of copper.

4.4. Testing experiment with real cell ON

- (1) You are now ready to use the instrument for measurement purposes. If you want to perform a simple checking experiment, you can use, for example, a 5 mM copper(II) solution in 0.1 M HNO_3 . Program your waveform generator for a conditioning potential $E_{\text{cond}} = +500$ mV vs. SCE, sweep from $E_1 = +500$ mV to $E_2 = 0$ mV, and back to $E_3 = +500$ mV; the final potential should be $E_4 = E_{\text{fin}} = +500$ mV. If you are using the VOLTSCAN Real-Time Data Acquisition and Control System, set the data in the PARAMETERS Table as follows:

Potential mV vs. SCE	Holding time s	Scan Rate mV/s
E1 = +500	1	100
E2 = 0	0	100
E3 = +500	0	100
E4 = +500	0	

(Number of) SCANS: 3

Follow the instruction manual for details of the VOLTSCAN operation.

- (2) Check if the *Reference Electrode* is connected and placed in the solution.
- (3) Check if the *Counter Electrode* is connected and placed in the solution.
- (4) Set the MODE switch on your potentiostat to select the PS (POTENTIOSTATIC) control.
- (5) Set the current range on your potentiostat to 1 mA FS (full scale).
- (6) Turn the CELL switch on your potentiostat to the ON (or: EXTERNAL CELL) position.
- (7) Turn the CONTROL switch on your potentiostat to the ON position.
- (8) Initiate the potential scan. Using the **OFFSET** knobs, appropriately

position the mass response curve on the recorder chart, or monitor plot.

- (9) Carefully change the cathodic potential limit E_2 to more negative one. Keep changing the E_2 value until the copper deposition just begins to take place. On the voltammogram, you should be able to observe an increase in the cathodic current due to copper deposition, and an increase of the anodic peak due to the copper stripping. On the *mass-potential* curve, which can be recorded simultaneously with the *current-potential* curve, you should observe a mass hysteresis with mass increase in the potential region where copper is being deposited, and a mass decrease which is fastest in the region of the stripping current peak. If mass changes in the opposite direction, change the **POLARITY** switch (+/-) setting. (When the working crystal frequency is lower than the reference crystal frequency, the mass increase is manifested by the increase in the measured frequency difference. When the working crystal frequency is higher than the reference crystal frequency, the mass increase is manifested by the decrease in the measured frequency difference.)
Do not deposit too much copper. During the anodic stripping process, very often a high concentration of the dissolved metal builds up in the vicinity of the electrode surface, and it may result in the formation of metal oxides on the electrode surface (the oxides may be sometimes difficult to remove).

Depending on your experiment and the range of your frequency measurement you may wish to increase the sensitivity of measurements by changing the **RANGE** selector or by increasing the sensitivity of the recorder, e.g., to 500 mV. (Be careful with whatever changes you make in instrument settings and connections because the instrument is capable of outputting $\nabla 15V$ at the **RECORDER V-OUT**). If you want to change the **RANGE** selector to more sensitive range, first offset the mass reading to zero (or close to zero) with **COARSE** and **FINE** offset potentiometers. The offset potentiometers will allow you to do measurements at high sensitivity on large signals.

4.5. Other utilities (Optional)

- (1) The frequency difference may be viewed and measured externally by connecting a measuring device to the **_F-OUT** BNC output located on the back panel of the instrument. This output provides a square wave logic signal of 0 V to 5 V and frequency indicated on the **FREQUENCY** panel meter (located on the left side of the front

panel).

- (2) The absolute frequency of the *working oscillator* **WO** and the *reference oscillator* **RO** may be viewed and measured externally by connecting a measuring device to the **F-OUT** BNC output located on the side panel of the Remote Probe Unit attached to the Faraday Cage. This output provides a high frequency square waveform (*ca.* 10 MHz), with amplitude 5 V_{p-p} and voltage levels 0 and +5 V. Use only short concentric cables (2-3 feet) to connect the **F-OUT** BNC socket to the measuring device (an oscilloscope or frequency meter). The **WO** and **RO** are selected with the toggle switch **F SELECT** located above the **F-OUT** socket.
- (3) This instrument may be used as a frequency meter. To do this, connect the frequency source to the BNC socket marked **PROBE 3** on the back panel of the Nanobalance Instrument EQCN-700. The voltage on this input *must be* a logic signal, 0 V to 5 V. Frequencies up to 500 kHz can be measured with a maximum resolution of 0.1 Hz.
- (4) (Optional) A synchronized gate output, **GATE OUT**, from the frequency meter, outputs a logical square wave, 0 V to 5 V, at a frequency of 0.1 Hz, 1 Hz or 10 Hz depending on the frequency sensitivity switch setting. (This output is not available on all instruments.).
- (5) The **DAMPING** selector switch controls a filter which damps the noise of the output voltage at the **RECORDER V-OUT**. Use the setting which works best for the particular experiment you are doing. Make sure that the damping acts only on the high frequency noise and not on the (slower) signal. The obtained curve should be more smooth (less noisy) but not more sluggish (signal should be intact). The time constants of the **DAMPING** are specially selected for typical scan rates used in cyclic voltammetry and microelectrogravimetry experiments. Usually, the first or second setting, from the left, is appropriate. The filter time constants increase, from left to right, in the following order:

FILTER POSITION	TIME CONSTANT <i>ms</i>	INDICATOR NUMBER
0	none	none (all OFF)
1	10	1
2	40	2
3	80	3
4	200	4

5

5. CRYSTAL-CELL ASSEMBLY

5.1. Mounting Quartz Crystals

- (1) Remove the rubber band and the metal cover can of the quartz crystal.
- (2) Carefully bend the contact spring wires close to the quartz crystal, such, that after sealing, the gold working electrode to be immersed in the solution will contact the blue wire and blue pin tip jack marked **Liquid**, inside the Faraday Cage.
- (3) Glue the crystal to the side opening in the cell.

5.2. Assembling Piezocells in ROTACELL Holder

- (1) Once the glue is dry, place the cell into the ROTACELL holder and adjust the height of the bottom support if necessary.
 - (2) Press the clip lever open and lock it in this position with the clip support by turning clockwise the black anodized aluminum knob in the bottom plate of the ROTACELL.
 - (3) Rotate the cell top plate (with the reference and counter electrodes) clockwise, out of the Faraday Cage, and place the cell underneath. Hold the cell and rotate it together with the cell top back to the initial position (inside the Faraday Cage). The quartz crystal sealed to the cell should be directed toward you so that the contact pins extending from the crystal will not be damaged by the clamp fixture. After the cell top, with the cell, is rotated back into the Faraday Cage and the cell is fully supported by the bottom plate of the ROTACELL, carefully turn the cell clockwise until the crystal pins slide onto the disk shaped contacting metal pads which are hot-pressed into the clamp base block.
 - (3) While pressing firmly the clip lever, release the clip support by turning the
-

black anodized aluminum knob in the bottom plate counter-clockwise. Then, by slowly releasing the clip lever, lower the clip jaw until it touches the crystal pins and secures their contact to the metal pads.

NOTE: If the crystal pins do not move unobstructed to the contact plates of the clip, remove the cell and gently pull the crystal pins to bend the spring wires. Once the pins are positioned flat on the contact plates, release the clip lever. If the crystal pins are not on the level of the contact metal pads, adjust the height of the clip base block using the spring loaded screws beneath the base plate.

- (4) Check if the cell is tightly positioned in the holder. If it is loose, press the clip to free crystal pins, and remove the cell from the holder. Adjust the bottom support level and start from (2), again.

5.3. Disassembling Piezocells from ROTACELL Holder

- (1) To remove the cell from the ROTACELL holder, press the clip lever open and lock it in this position with the clip support by turning clockwise the black anodized aluminum knob in the bottom plate of the ROTACELL.
- (2) Very carefully rotate the cell counter-clockwise to free the crystal pins from the clip.
- (3) Now, holding the cell and the top plate with the right hand, rotate them clockwise, out of the Faraday Cage, while keeping the bottom plate from moving with the left hand. Remove the cell by moving it downward. Clean the reference electrode and counter electrode.

5.4. Final checks

- (1) Check the assembly in order to avoid a short circuit across the contact plates in the clip.
 - (2) Make sure there is no significant strain on the crystal pins.
 - (3) Make sure there is no solution spills on the air-side of the quartz crystal. Any mass change on the air-side of the quartz crystal will also influence the frequency of oscillation.
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6. ELECTRICAL CIRCUITS

7. SERVICING NOTES

In case of malfunction of the EQCN-700 instrument, the unit may be returned to the factory for service. It should be returned postpaid. Since the equipment is guaranteed for one year, no charges for repair will be made for time and materials. The guarantee does not cover misuse of the Model EQCN-700 or damage due to improper handling or service.

WARRANTY

All our products are warranted against defects in material and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products which prove to be defective during the warranty period. We are not liable for direct, indirect, special, incidental, consequential, or punitive damages of any kind from any cause arising out of the sale, installation, service, or use of our instrumentation.

All products manufactured by ELCHEMA Company are thoroughly tested and inspected before shipment. If ELCHEMA receives notice from the Buyer of any defects during the warranty period, ELCHEMA shall, at its option, either repair or replace hardware products which prove to be defective.

Limitation of Warranty

- A. The Warranty shall not apply to defects resulting from:
 - 1. Improper or inadequate maintenance by Buyer;
 - 2. Unauthorized modification or misuse;
 - 3. Operation in corrosive environment (including vapors, solids, and aggressive solvents);
 - 4. Operation outside the environmental specification of the product;
 - 5. Improper site preparation and maintenance.
- B. In the case of instruments not manufactured by ELCHEMA, the warranty of the original manufacturer applies.
- C. Expendable items, including but not limited to: glass items, reference electrodes, valves, seals, solutions, fuses, light sources, O-rings, gaskets, and filters are excluded from warranty.

THE WARRANTY SET FORTH IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. ELCHEMA SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

For assistance of any kind, including help with instruments under warranty, contact your ELCHEMA field office of instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service date and shipping instructions will be promptly sent to you. There will be no charges for repairs of instruments under warranty, except transportation charges. Estimates of charges for

non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING THE INSTRUMENT FOR WARRANTY REPAIR

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your ELCHEMA field office is ready to assist you in any situation, and you are always welcome to get directly in touch with the ELCHEMA Service Department:

ELCHEMA
Customer Support
P.O. Box 5067
Potsdam, NY 13676
Tel.: (315) 268-1605
FAX: (315) 268-1709