

**INSTRUCTION MANUAL
FOR E5550 FILM THICKNESS
MONITOR AND CONTROLLER**

1. GENERAL DESCRIPTION

The Bio-Rad E5550 Film Thickness Monitor and Controller operates by monitoring the frequency shift of an oscillating quartz crystal when loaded with evaporated material deposited on the crystal.

The frequency shift is related to the mass of the deposited material and thus calibration of the thickness depends on area of crystal exposed (fixed by the design of the crystal holder) and the density of the material being deposited.

When using the equipment, it is always assumed that the source to crystal and source to substrate distances are the same, and it must be remembered that the thickness of coatings (from a point source) will be inversely proportional to the square of the distances. If these distances do differ, a constant factor can be applied to the real density of the material being deposited to compensate accordingly, i.e. the ratio of the distances squared.

2. INSTALLATION

2.1 The E5550 Film Thickness Monitor is supplied as follows:

- (a) Control monitor
- (b) Oscillator
- (c) Co-axial lead with BNC terminations
- (d) Crystal holder with vacuum feedthrough with two spare crystals (optional)

(a) CONTROL MONITOR

Check that the voltage label on the unit supplied corresponds to the laboratory supply

The control module may be supplied as a free standing unit or panel mounted with equipment.

The front panel of the instrument comprises a three digit display calibrated in nanometres (1 nanometre = 10 Angstroms), a mains power ON/OFF switch, a thumbwheel switch for selecting DENSITY, a RANGE switch (range 1 giving a 0.1nm resolution and range 2 giving a 1nm resolution), a thumbwheel switch to SET THICKNESS of desired film, a green START button to start the evaporation process illuminating a red LED and a red STOP button which may be used to abort the evaporation process. The ZERO knob is a combination of coarse and fine control to zero the display before commencing a control process. When adjusting the zero control, the knob turns easily (fine control) and will then reach an apparent stop. Firmer rotation (coarse control) will then continue to change the display reading.

The rear panel (free standing model only) comprises the BNC connector to connect the co-axial lead to the oscillator. control function operates via an internal relay contact (240V 8A) which can be wired to the users system via the three pin socket (plug supplied) connecting the two lower terminations, the third termination being at earth (ground) potential. The fuse is a 20mm 100mA antisurge

OSCILLATOR

The oscillator is supplied inside a small black box with integral male and female BNC connectors. The oscillator must be connected as close as possible to the crystal holder and preferably no more than 0.5 metres from it. For maximum reliability, it is important that the capacitance of the crystal circuit matches the oscillator compensation which is marked on the box.

$$C_{\text{compensation}} = C_{\text{cable}} + C_{\text{connector}} + C_{\text{electrodes}}$$

where $C_{\text{cable}} = 100\text{pF/metre}$ for 50 ohm cable

or 65pF/metre for 75 ohm cable

$C_{\text{connector}}$ is negligible in most cases

and $C_{\text{electrode}}$ is 15pF for the 5MHz crystal supplied.

The capacitor between pins 1 and 5 provides the compensation for the cable capacitance and additional capacitors may be placed in parallel if required. Note: This will be adjusted if the crystal holder feedthrough assembly has been supplied with the unit.

CO-AXIAL LEAD

The co-axial lead supplied is normally 1.2metres long with 50 ohm cable and is connected from the rear panel of the monitor unit to the oscillator.

CRYSTAL HOLDER WITH VACUUM FEEDTHROUGH

Crystal holders and vacuum feedthroughs vary widely and are supplied to users requirements. Some crystal holders are water cooled and therefore a water feedthrough into the vacuum will be required.

When co-axial cable is used to connect the feedthrough to the crystal holder, earth (ground) loops must be avoided if crystal holder is mounted on the jigging and in electrical contact to it. It is preferred to make use of this return path and break continuity in the braiding of the co-axial cable

2.2 INSTALLATION

- (a) Fit vacuum feedthrough
- (b) Fit crystal holder into desired position as close to substrate as is convenient.
- (c) Connect crystal holder to feedthrough (See 2.1 d)
- (d) Connect oscillator (see 2.1 b).
- (e) Connect oscillator to monitor
- (f) Connect monitor to mains power (check voltage label)
- (g) Connect relay contacts (via plug and socket) in series with mains voltage live line to evaporation supply 240V/8A max)
See 2.1 a. Additional vacuum interlocks to these supplies should be left intact.

3. OPERATION

It is assumed that the vacuum system has been evacuated and is ready for use

- (a) Switch on mains power switch
- (b) Dial in density of evaporant or material for sputtering.
- (c) Use ZERO adjustment to set digital display to "0". Remember that this knob is a combined coarse/fine control

Set range switch as required and dial in required thickness (Range 2 in nanometres). Note that range 1 has a resolution of 0.1nm and the set thickness will indicate in the same manner, i.e. the final digit is 0.1 to 0.9 nm.

Press START button when the other functions are prepared for the coating operation i.e. correct voltage applied to evaporation filament/boat or correct argon bleed rate/current conditions for sputtering). The process can be aborted by depressing the STOP button, otherwise the process will terminate at the set point.

4. ADDITIONAL NOTES

Typical densities for materials:

Gold	19.4g/cc
Gold/18.5%Palladium	18.0g/cc
Platinum	22.1g/cc
Silver	10.5g/cc
Nickel	8.3g/cc
Aluminium	2.6g/cc
Carbon	2.2g/cc

Quartz crystal

quartz crystal is a 5MHz AT cut planoconvex crystal operating in parallel resonance. It will function normally until the total thickness of deposited material causes the oscillation frequency

to fall outside the range of the range of the measuring system. This corresponds to about 11 microns of aluminium or 2 microns of gold. The digits on the display will then no longer alter during deposition nor will the user be able to zero the instrument. A similar effect will be observed if the contact to the crystal in the holder is faulty. The crystal must then be changed. This is accomplished done unscrewing the top plate of the crystal holder. When rescrewing the top plate, care must be taken so that the crystal contact is not damaged and this is best done by depressing the crystal against the spring with a cotton bud whilst screwing up the holder

It is not recommended to attempt to recover used crystals.