



Quorum Technologies

FT7690 Film Thickness Monitor

Operating Manual



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Quorum Technologies

Quorum Technologies Ltd is the owner and manufacture of the preparation equipment.



range of EM

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- Carbon and Sputter Coaters
- Plasma Reactor for ashing and etching
- High Vacuum Bench Top Evaporators
- Cryo Transfer Systems
- Critical Point Dryers
- Service and Spares

Disclaimer

The components and packages described in this document are mutually compatible and guaranteed to meet or exceed the published performance specifications. No performance guarantees, however, can be given in circumstances where these component packages are used in conjunction with equipment supplied by companies other than Quorum Technologies.



1 Contents

1.1 Manual Layout

This Operating Manual is divided up into the following major section, each chapter dealing with specific topics, as follows:

Chapter 1 - Contents

Chapter 2 - Health and Safety

Summary of Health and Safety issues.

Chapter 3 - Introduction

Introduces this manual.

Chapter 4 - General Description

Identifies each of the equipment items and provides an overview of their functions and how they work.

Chapter 5 - Installation

Instructions on how this equipment should be installed and the connections which should be made between the equipment items.

Chapter 6 - Operation

Instructions on how to start-up and run the equipment.

Chapter 7 - Maintenance

Instructions on how to check the system is functioning correctly.

Chapter 8 - Fault Finding

Information on how to identify faults in the system and how to rectify these faults.

Chapter 9 - Agents

List of main agents supporting the Quorum Technologies product range

Chapter 10 - Index

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2 Health and Safety

Safety is very important when using any instrumentation.

This manual does not contain a detailed Health and Safety section as the equipment is an optional item to be used with other equipment supplied by Quorum Technologies's within the Polaron range of products where a full Health and Safety section will be found in that manual.

For a full section on Health and Safety covering service, hazard signals and signs, risk analysis and good working practices, refer to Manual **OM-SC7640** for the SC7640 Sputter Coater, Manual **OM-E6300** for the E6300 Bench Top Evaporator or Manual **OM-E6700** for the E6700 Bench Top Evaporator.

2.1 Control of Substances Hazardous to Health (COSHH)

The E.C. legislation regarding the "Control of Substances Hazardous to Health" requires Quorum Technologies to monitor and assess every substance entering or leaving their premises. Consequently any returned goods of whatever nature must be accompanied by a declaration form available from Quorum Technologies, reference number SP-100). Without this declaration Quorum Technologies reserves the right not to handle the substance/item. Also in accordance with E.C. regulations we will supply on request hazard data sheets for substances used in our instruments.

2.2 Safety Policy

Quorum Technologies is committed to providing a safe working environment for its employees and those that use it's equipment and conducts its business responsibly, and in a manner designed to protect the health and safety of its customers, employees and the public at large. It also seeks to minimise any adverse effects that its activities may have on the environment.

Quorum Technologies regularly reviews its operations to make environmental, health and safety improvements in line with UK and European Community legislation.

Quorum Technologies cannot be held responsible for any damage, injury or consequential loss arising from the use of its equipment for any other purposes, or any unauthorised modifications made to the equipment.

All service work carried out on the equipment should only be undertaken by suitably qualified personnel. Quorum Technologies is not liable for any damage, injury or consequential loss resulting from servicing by unqualified personnel. Quorum Technologies will also not be liable for damage, injury or consequential loss resulting from incorrect operation of the instrument or modification of the instrument.

2.3 Conformity

This instrument is supplied in a form that complies with the protection requirements of the EC Electromagnetic Compatibility Directive **89/336/EEC** and the essential health and safety requirements of the low voltage directive **72/23/EEC** both as amended by **92/31/EEC**. Any modifications to the equipment, including electronics or cable layout may affect the compliance with these directives.

3 Introduction

This manual is intended for all users of the **FT7690 Film Thickness Monitor** manufactured by Quorum Technologies and provides information on the installation, operation and maintenance of the instrument.

Please note that the servicing and maintenance procedures should only be carried out by qualified service personnel and it is essential that all users should read the **Health and Safety** section of the manual for the appropriate Sputter Coater or Evaporator where the film thickness monitor is being used.

3.1 Return of Goods

If goods are to be returned to Quorum Technologies for repair or servicing the customer should contact their local distributor or the factory direct before shipment. A "Returns Authorisation Number" should be obtained in advance of any shipment. This number is to be clearly marked on the outside of the shipment. Complete the returned equipment report form, number **SP106** with as much detail as possible and return with the goods.

All returned goods are to be accompanied by a completed "Returned Goods Health and Safety Clearance" form **SP-100** attached to the outside of the package (to be accessible without opening the package) and a copy of the forms should be faxed in advance to the factory.

When goods are to be returned under warranty refer to the "Warranty Claim, Repair and Returns Procedure" form number **SP-105**

Copies of all these three forms can be found in the documentation pack supplied with the instrument or direct from Quorum Technologies, the details can be found on page two of this document.

3.2 Returns Procedure

Warranty Claim

Electronic and basic servicing capabilities exist at most in-country Thermo companies and at appointed agents, however all components are sold with a **return to factory warranty** (unless otherwise stated) which covers failure during the first 12 months after delivery.

Returns must be sent carriage paid, Quorum Technologies will cover the return carriage costs. This covers defects which arise as a result of a failure in design or manufacturing. It is a condition of warranty that equipment must be used in accordance with the manufacturers instructions and not have been subjected to misuse. This warranty does not cover consumable items such as sputter coating targets and carbon evaporation material. To make a claim under the terms of this warranty provision contact the Customer Service Department at your local Quorum Technologies Representative in the first instance.

Chargeable Repairs

Always contact your in-country Quorum Technologies Representative in the first instance. They will be pleased to assist you and will be able to provide an estimate of repair costs, many offer local repair facilities.

For routine repairs where down-time is not critical. The target standard return time at Quorum Technologies is 20 working days.

Returns

All returns to Quorum Technologies require the following procedure to be followed:

1. Contact the local Quorum Technologies Representative and request a Returns Authorisation Number.
2. Complete a Returned Goods Health and Safety form and returned equipment fault report form.
3. Attach a copy of the completed form to the outside of the package with the usual shipping documents.

Packaging and Carriage

All goods shipped to the factory **must** be sealed inside a clean plastic bag and packed in a suitable carton. If the original packaging is not available Quorum Technologies should be contacted for advice. Quorum Technologies will not be responsible for damage resulting from inadequate returns packaging or contamination of delicate structures by stray particles under any circumstances. All non-warranty goods returned to the factory must be sent carriage prepaid, (Free Domicile). They will be returned carriage forward (Ex-Works).

4 Description

4.1 Equipment

The **FT7690 Film Thickness Monitor** is available for both 240 and 110 volt supply. An operation manual **OM-FT7690** is supplied with each unit.

FT7690	Film Thickness Monitor, Selectable 110-120v or 220-240v supply. Complete with oscillator and cables.
FT7607	Stage incorporating FTM crystal holder. (For SC7640 sputter coater only) or
E5511	Quartz crystal holder. (For E6300 and E6700 Evaporator)
FT533	Spare quartz crystals.

4.2 Overview

A variety of techniques are available for depositing thin films on substrates; in EM these typically include sputter coating and evaporation of metals from a filament source. Accurate measurement and control of the thickness of such films is often critical in achieving the desired results. The **FT7690** Film thickness Monitor is an easy to use module that not only allows measurement of films, but is also able to terminate the deposition process at a predetermined thickness.

A good example of the value to this technique is the sputtering of fine grain coatings, typically Gold/Palladium or Platinum, required for high resolution SEM. Here accuracy is essential due to the relationship between coating thickness and grain size - the thicker the film the larger the individual metal grains within that film. For this reason the FT7690 Monitor and FT7607 are recommended for use with the SC7640 High Resolution Automatic/Manual Sputter Coater and the E5511 Quartz Crystal Holder for the E6300 and E6700 Evaporators.

4.3 Technical Specification

FT7690 Film Thickness Monitor Specification

Range	0.0nm to 999.9nm.
Display resolution	0.1nm.
Display	Four digit display for three values: Density, termination point and percentage use.
Quartz power	5MHz (new), operating range 4.5MHz to 5.1 MHz, internal oscillator.
Power	Selectable 110V, 220V or 240V at 50 or 60 Hz.

4.4 General Description

The Quorum Technologies **FT7690** Film Thickness Monitor and Controller operates by monitoring the frequency shift of an oscillating quartz crystal as evaporated material is deposited on the crystal. The frequency shift is related to the mass of the deposited material and thus calibration of the thickness depends on the 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 inverse ratio of the distances squared. The deposition thickness can also be calculated from the measured frequency and the programmed density.

$$T_f = D_q \times N_q \times T / \pi \times D \times \arctan(\tan(\pi \times (1 - T_5/T)))$$

where

- T_f = Film Thickness
- D_q = Density of quartz
- N_q = Frequency constant of quartz
- T = Period of loaded quartz
- D = Density of evaporated material
- T_5 = Period of 5MHz crystal

The **FT7690** FTM uses a simple digital four digit "auto zero" display that makes it easy to set up and operate and can be fitted to the E6700 to monitor the metal evaporation or sputtering process and terminate it when the required thickness is reached. The deposition thickness is selected and controlled to 0.1 nm with a range of 999.9 nm. The density of the evaporant is selected and the percentage of the crystal useful life can be displayed. The crystal life is typically 2-4 microns for gold. The unit operates using an oscillating 5MHz crystal and monitoring the change of resonant frequency as the crystal becomes loaded with evaporant.

The control module is supplied as a free standing unit. The top panel of the instrument comprises a four digit LED display calibrated in nanometres (1 nanometre = 10 Ångstroms) with a resolution of 0.1 nm, SET key, process START/ STOP key and UP and DOWN select buttons.



Figure 4.1 FT7690 Film Thickness Monitor

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.

5 Installation

Quorum Technologies has carefully packed the **FT7690 Film Thickness Monitor** so that it will reach its destination in perfect operating order. Do NOT discard any packing materials until the unit has been inspected for any transit damage and the instrument has been used to the customer's satisfaction.

If any damage is found, notify the carrier and Quorum Technologies (or local agent) immediately. If it is necessary to return the shipment, use the packaging as supplied and follow the instructions in this manual for return of goods paragraph 3.1.

5.1 Unpacking Checklist

The Equipment package will normally be despatched from the factory in one box. Inside the box the following will be found, refer and check each item off against the supplied packing list.

- ◆ **FT7690 Film Thickness Monitor** - packed in a polythene bag.
- ◆ **FT7690 Oscillator with BNC terminations, Mains cable, 3-pin connector and spare fuzes.**
- ◆ **Documentation** - Inserted in a folder, containing the operating manual and a standard forms pack.

5.1.1 Electricity

Ensure that a suitable **mains electricity supply** (110 Vac or 240 Vac, frequency 50/60 Hz) is available. Check that the voltage label attached on the rear of the cabinet is suitable for the local voltage and frequency.

Connect the power lead to a suitable three pin power plug of adequate rating (6 amps) and ensure that a proper earth (ground) connection is made.

Connect the power lead using the convention: Brown - Live, Blue - Neutral, Green/Yellow - Earth.

5.2 Connections

The BNC connector on the rear panel is connected to the oscillator which is part of the double ended BNC cable assembly. The length of the cable between the vacuum feedthrough and the crystal holder should not exceed 300mm. The 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 outer terminations. The fuse is a 20mm 100mA anti-surge.

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 vacuum feed through via the oscillator.

When co-axial cable is used to connect the feedthrough to the crystal holder, earth (ground) loops must be avoided if the 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.

- (a) Fit vacuum feedthrough
- (b) Fit crystal holder into desired position as close to substrate as is convenient.
- (c) Connect crystal holder to feedthrough.
- (e) Connect feedthrough socket to the oscillator cable assembly and then to FTM.
- (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) Additional vacuum interlocks to these supplies should be left intact.

6 Operation

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

- (a) Apply line voltage to the FTM. At switch on, the four digits will blank and then the software version number fitted to the unit will be displayed for several seconds before the FT7690 FTM will revert to it's default thickness display.
- (b) Depress the SET key and the DENSITY LED will be illuminated. Select the density of the material to be evaporated by depressing the UP/DOWN buttons until the required density is displayed.

NB The display will always default to thickness after several seconds if no further function is selected.
- (c) Depress the SET key to select TERMINATE. The thickness of evaporant required can now be selected using the UP/DOWN buttons. The TERMINATE LED remains illuminated during this selection.
- (d) Depress the SET key again and the % USED LED will illuminate. The display will read the extent of use of the crystal. When the display indicates that usage approaches 100%, be aware that the control and indication may be lost if the crystal is not replaced. The thickness display will show four zeroes if the measurement range has been exceeded. If the crystal fails during a process run, the unit will retain the last calculated thickness and when the crystal is replaced, starting the process restores the initial thickness value rather than zero.
- (e) Press START/STOP key to start the process having set the correct voltage applied to evaporation filament/boat or correct argon bleed rate/current conditions for sputtering. The thickness display is automatically zeroed. The process can be aborted by depressing the START/STOP key again, otherwise the process will terminate at the set point.

NOTE: If the crystal is overloaded during an evaporation process, the process state will be HELD. This will be indicated by the START/STOP LED flashing and the control relay will terminate the evaporation process.

Default Display

The unit will automatically revert to the default thickness display after a short delay whenever the SET key is depressed to view any of the parameters even during the evaporation process.

The delay is typically 12 seconds but only 3 seconds if the process is running or held.

6.1 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
Chromium	7.2g/cc

6.2 Quartz Crystal

The quartz crystal is a 5MHz AT cut planoconvex crystal operating in parallel resonance.

The measuring range of the system corresponds to about 11 microns of aluminium or 2 microns of gold.

When rescrowing the top plate of the crystal holder, 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.

A pack of three replacement crystals are available under product code FT553.

6.3 Test Mode

By simultaneously depressing the SET and START/STOP buttons, the test mode is selected. The test mode performs the following sequence.

All LEDs and LED segments are lit and remain lit for 10 seconds immediately after the buttons are released.

The internal relay is opened for one second and closed for one second. This is repeated three times.

The four least significant digits of the measured frequency are displayed and the % Usage LED flashes. The START/STOP key is operational.

The test mode is exited by again depressing the SET and START/STOP buttons simultaneously.

7 Maintenance

The FT7690 Film Thickness Monitor unit requires very little in the way of routine maintenance, however, for optimum performance it is recommended that the following procedure is carried out on a regular basis.

- (a) Inspect all connections for security and signs of wear.
- (b) Clean the outside surfaces of the cabinet with a damp cloth or proprietary equipment cleaner. Finish with a dry, lint free cloth to remove smearing.

8 Fault Finding

We hope that you experience the minimum of problems throughout the lifespan of the equipment but inevitably problems may occur. Any known problems associated with this type of equipment has been listed below with the possible cause and suggestions to what to do. If problems continue to occur, contact the Customer Service Department at Quorum Technologies or your local agent, see section 9 for list of agents.

8.1 Fault Prevention

It is assumed that with a system in regular use and that the system was installed in a suitable environment and in regular use, faults will be repaired as they occur.

8.2 Error Codes

8.2.1 Power up Tests:

When the unit is switched on, it performs several tests. The following error codes may be displayed if an error is detected.

- E1 Counter circuit error
- E2 Ripple counter error
- E3 EPROM ID error
- E4 Unable to program counter
- E5 Counter 2 error
- E6 Key stuck on

8.2.2 Run Time Errors

If an error occurs during operation, the unit may report one of the following error codes

- E101 Counter 1 cannot be programmed
- E102 Counter 2 cannot be programmed
- E103 Counter 3 cannot be programmed
- E104 Counter circuitry error

If an error is displayed, the error code should be noted and the unit switched of and then on again. If the error code persists, the unit should be returned for service.

9 Agents

List of Agents Supporting Quorum Technologies products.

H D Scientific Supplies Pty Ltd P O Box 6044 Blacktown Business Centre SIDNEY NSW 2148 AUSTRALIA Tel: 61 2962 16955 Fax: 61 2967 12293	Philips Electron Optics BV Building AAE Achtseweg Noord 5 PO Box 218 5600 MD EINDHOVEN HOLLAND Tel: 31 40276 6786 Fax: 31 40276 5141	Medic Corporation Ltd. 20 Peterkin Street Wingate, Private Bag LOWER HUTT NEW ZEALAND Tel: 64 577 0000 Fax: 64 577 2000	Omega Scientific Taiwan Ltd. 5F-1,415 Sec. 4 Hsin Yi Road TAIPEI TAIWAN, ROC Tel: 886 28780 5228 Fax: 886 28780 5225
Labco gmbH Dr - Tritemmel - Gasse 8 A3013 PRESSBAUM AUSTRIA Tel: 43 2233 53838 Fax: 43 2233 53176	OED Technology Limited 22/F Beltrade Commercial Building 3 Burrows Street WANCHAI HONG KONG, CHINA Tel: 852 838 2377 Fax: 852 838 0091	Nerliens Kemisk-Tekniske Aktieselskap Kampengaten 18 N-0654 OSLO NORWAY Tel: 47 2268 5070 Fax: 47 2267 6506	Zen-Yan Scientific Co. Ltd. N° 19, Lane 43 His-Tsun Road Dai-Li City TAICHUNG TAIWAN, ROC Tel: 886 4393 2897 Fax: 886 4393 2401
Soquelec Limited 5757 Cavendish Building Suite 101 MONTREAL QUEBEC H4W 2W8 CANADA Tel: 1 514 482 6427 Fax: 1 514 482 1929	Auro-Science Consulting Ltd Varosfal Kos 5 Postabok 234 1300 BUDAPEST HUNGARY Tel: 361 242 1390 Fax: 361 242 1391	Solid Quest Inc 7 th Floor Westgate Tower Investment Drive Madrigal Business Park Ayala Alabang MUNTINLUPA CITY 1780 PHILIPPINES Tel: 632 850 5759 Fax: 632 850 5961	Becthai Bangkok Equip. Co Ltd. 308/1 Phaholyothin Road Phayathai BANGKOK 10400 THAILAND Tel: 66 2615 2130 Fax: 66 2271 4533
Soquelec Ltd. P O Box 42056 128 Queen Street South Mississauga ONTARIO L5M 4Z0 CANADA Tel: 1 905 569 6613 Fax: 1 905 569 7171	Harley Instruments Plot No. 4, Survey No. 47 Poona Satara Road POONA 411009 INDIA Tel: 91 2042 20602 Fax: 91 2042 20843	Labometer Lda Rue Duque de Palmela No. 30 10 F/G 1250-098 LISBOA PORTUGAL Tel: 351 2135 10180 Fax: 351 2135 25066	Tekser Koll Sti Acibadem Ca. Erdem Sok Baver Apr. No 6/1 Uskudar ISTANBUL 81010 TURKEY Tel: 90 216 327 4041 Fax: 90 216 327 4046
Edrin s.r.o Kon vova 141 130 83 PRAHA 3 CZECH REPUBLIC Tel: 42 2671 08255 Fax: 42 2671 08335	Eisenberg Brothers 13 Gush Etzion St GIVAT SHUMEL 54030 ISRAEL Tel: 972 3532 1715 Fax: 972 3532 5696	Antech Instruments PTE Ltd. 150 Kampong Ampat #05-02 KA Centre SINGAPORE 368324 Tel: 65 289 5500 Fax: 65 289 5522	Agar Scientific 66a Cambridge Road STANSTEAD Essex, CM24 8DA UNITED KINGDOM Tel: 1279 813519 Fax: 1279 815106
Ax Lab A/S Strandboulavarden 64 DK-2100 COPENHAGEN DENMARK Tel: 45 3543 1881 Fax: 45 3543 0073	Jeol (Italia) S.p.A. Centro Direzionale Ripamonti Via Dei Tulipani 1 PIEVE EMANUELE (MI) 20090 ITALY Tel: 39 02904 1431 Fax: 39 02904 14303	Set-Point Technology SMM House, 543 Kyalami Boulevard Kyalami Business Park Midrand, 1686 PO Box 11400, VORNA VALLEY SOUTH AFRICA Tel: 27 11466 2200 Fax: 27 11466 2268	ISS Pellowe House Francis Road Withington MANCHESTER, M20 9XP UNITED KINGDOM Tel: 161 445 5446 Fax: 161 445 4914
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Gala Instrumente gmbH An der Schalmach 42 BAD SCHMALMACH D-65307 GERMANY Tel: 49 6124 77952 Fax: 49 6124 60274	Topcon Electron Beam Services Corp 75 - 1 Hasunuma - Cho Itabashi - KU TOKYO 174 JAPAN Tel: 813 3558 2588 Fax: 813 5392 4992	Leica Espana SA Nicaragua 46 BARCELONA 08029 SPAIN Tel: 34 93 49 49530 Fax: 34 93 49 49532	Leo Electron Microscopy Ltd. Clifton Road CAMBRIDGE, CB1 3QH UNITED KINGDOM Tel: 1223 414 166 Fax: 1223 412 776
Asteriadis S.A 56 - 58 Spirou Trikoupi PO Box 26140 GR-100 22 ATHENS GREECE Tel: 30 1 823 5383 Fax: 30 1 823 9567	Hi-Tech Instruments Sdn 60 Jalan Ind. PBP 3 Taman Ind Pusot, Bandar, Puchong 47100 PUCHONG, Selangor MALAYSIA Tel: 60 3589 11638 Fax: 60 3589 11639	Aname C/Jose Fernandex Cuevas 14-B-282244 Pozvelo de Alarcon MADRID SPAIN Tel: 34 91 352 3084 Fax: 34 91 352 3322	Rontec (UK) Ltd Pellowe House Withington MANCHESTER, M20 9XP UNITED KINGDOM Tel: 161 448 0688 Fax: 161 448 0224
Goffin Meyvis P O Box 265, Pergolesilaan 4 4600 AG BERGEN op ZOOM HOLLAND (Also covers, BELGIUM & LUXEMBOURG) Tel: 31 1642 90000 Fax: 31 1642 66651	Prisma Scientific Instruments Services S/B (P.S.I.S.) No. 15B & 15C Jalan Kenari 8 Puchong Jaya Selangor Darul Ehsan PUCHONG 47100 MALAYSIA Tel: 60 3575 2035 Fax: 60 3575 3104	Atema Instrument P O Box 7075 Gillbostraket 8 S-19207 SOLLENTUNA SWEDEN Tel: 46 8626 8365 Fax: 46 8626 8355	Energy Beam Sciences PO Box 468 11 Bowles Road AGAWAM MA01001 UNITED STATES OF AMERICA Tel: 1 413 786 9322 Fax: 1 413 789 2786

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