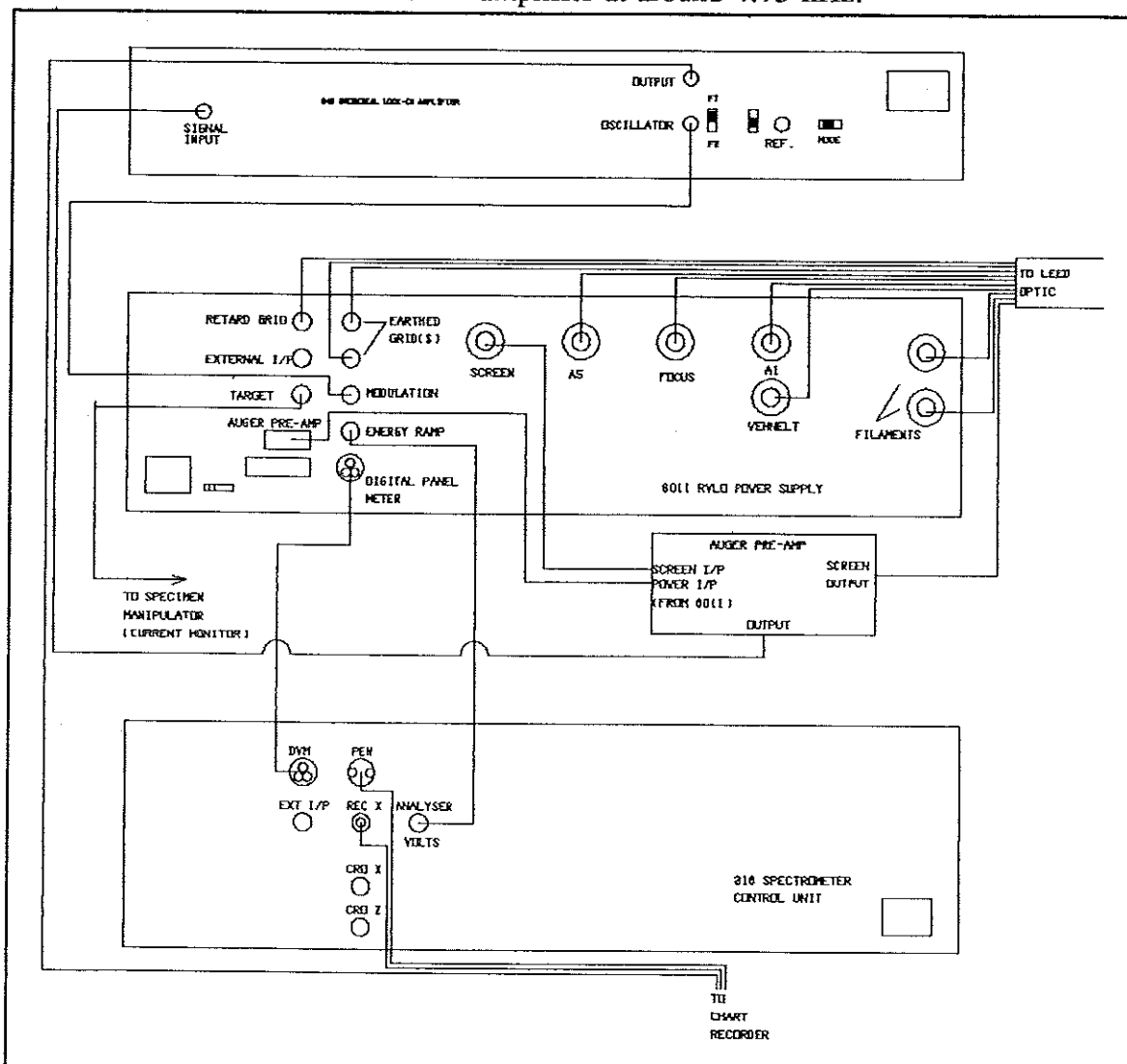
RV010 **RVLO AUGER OPERATING INSTRUCTIONS**

INTRODUCTION

In order to perform Auger analysis, it is necessary to apply a modulation to the retarding mesh voltage of the optic and to detect the resultant modulation of the electron beams reaching the screen. In addition, the electron gun energy must be increased to a few KeV to excite the Auger transitions.

The 8011 RVLO power supply unit is designed to be operated in conjunction with a model 340 (modified) Brookdeal Lock-in amplifier and a model 318 Spectrometer Control unit. A pre-amplifier is also used which is factory tuned to the second harmonic of the output of the internal oscillator of the lock-in amplifier at around 4.75 kHz.



Differential Auger Wiring Diagram

WIRING

The normal method of working with 3 mesh optics is to have M1 and M2 at the retard potential and M3 earthed. For 4 grid optics, M2(A and B) are at retard while M1 And M3 are earthed.

In normal operation, the ramp output of the spectrometer control unit drives the ramp input of the 8011. The modulation output from the 340 is connected to the modulation input of the 8011. The pre-amplifier is inserted between the optic screen and the screen voltage output of the 8011. The output from the pre-amplifier goes to the input of the 340 and the output of the 340 drives a chart recorder or other recording device. One further connection required is from the DPM output socket of the spectrometer control unit to the auxilliary input of the 8011 to allow the spectrometer energy to be displayed on the 8011 DPM.

With the units wired in this manner for a four mesh optic it is possible to switch between Auger and Leed modes simply by switching the 'range' switch on the 8011. When 3keV is selected for the gun output, the circuits are automatically switched to Auger mode and the screen voltage reduced to approximately 250 Volts to collect electrons. The output of the lock-in amplifier drives a chart recorder Y motion and the Spectrometer control unit Rec X output drives the X motion. The recorder penlift is connected to the spectrometer control unit penlift output. For three mesh optics, the wiring of the optics should be changed in Auger mode so that M1 and M2 are at the retard potential and M3 is earthed.

PRE-AMPLIFIER

The pre-amplifier is tuned to the second harmonic of the output of a modified Brookdeal lock-in amplifier. The frequency of the fundamental is around 2.375kHz.

The controls are pre set at the factory and should not normally require further adjustment .

If for some reason it becomes necessary to re-tune the pre-amplifier,the following procedure should be used:-

The Lock-in amplifier may be switched at the rear panel to give an output at the second harmonic frequency by moving a switch from f1 to f2. Having selected f2 using this switch, connect an oscilloscope to the output of the pre-amplifier. The electron gun should be switched off and a modulation of 5V p-p should be applied to the optic. This can be measured using an oscilloscope at the oscillator output socket of the lock-in amplifier The pre-amplifier 'tune' control may then be adjusted for maximum response. The oscilloscope should be connected to the output of the pre-amplifier for this test. (A double beam oscilloscope is useful for this). After switching back to f1 at the rear panel, the 'nulling' controls should be adjusted to give a minimum response to the second harmonic(4.75kHz), this 'tunes out' the feedback of the oscillator due to stray capacitance between the meshes and the interconnecting cables. The nulling controls are very comprehensive, giving control over the level and phase of the negative feedback but in most cases, only slight adjustment of the 'ratio' and phase controls should be found necessary.

SPECTROMETER CONTROL UNIT 318

The 318 Spectrometer control unit provides the ramp voltage for the retard grid(s) of the optic in Auger mode.

Controls

The front panel controls are as follows:-

Pedestal controls- Coarse,medium and fine controls are used to set the initial value of the spectrometer energy scan. (The sweep switch should be in the 'reset' position)

Sweep controls- A toggle switch is used to start the scan and to reset it on completion. In the central position the switch will hold the chart recorder pen up. The amplitude or range of the scan is set by a 7 position switch between 1 volt and 1000 volts. The time for completion of a scan is set by another 8 position switch. In the EXT I/P position, the ramp is controled by a rear panel input socket (0 to 10V for full scan range as set by the amplitude switch). In the REP (repeat) positions, the scan is repeated at either 120ms (fast) or 1.2s (slow). This allows the use of an oscilloscope for recording purposes.

Rear Panel

The rear panel outputs are as follows:

DVM- This socket gives an output proportional to the spectrometer energy for monitoring purposes. (1 volt represents 1000V).

Pen- Pen lift control output to chart recorder. (relay contacts closed during scan, open on penlift or reset)

Ext I/P- External drive for spectrometer ramp. 1mV input gives 1v Energy output.

Rec X- Chart recorder X drive. 0 to -2.5V.

Analyser Volts- Output voltage to 8011 RVLO power supply.

CRO- Oscilloscope X drive and Z (flyback blanking) output.

M.E.- Master Earth: Zero reference level for the electronics. normally connected to chart recorder X drive +ve wire.

LOCK-IN AMPLIFIER

The lock-in amplifier controls are basically self explanatory, allowing a wide range of sensitivity and zero suppression selection. The required time constant should be selected at the lock-in amplifier 300mS is a convenient starting point. The oscillator providing the modulation is integral with the lock-in amplifier unit and an output amplitude control is provided though this need not be used normally as the required sensitivity may be selected by variation of the electron gun beam current.

The phase setting must be properly adjusted for correct operation. The setting should not need regular attention but may be checked as follows:- Press the 90° button to select the signal 90° out of phase. No Auger peak should be found on running a scan. (In fact a relatively small peak is permissible as the phase setting is not critical.) If adjustment is necessary to achieve the above condition a potentiometer provides continuous variation of phase. When satisfied that the signal has been reduced to a minimum, pressing the 90° button again will return the amplifier to the optimum phase setting. The 180° button inverts the spectrum if required.

The button marked 2f when pressed means that the first harmonic of the reference frequency is detected, giving two stages of differentiation of the integrated spectrum being detected. This gives the derivative spectrum normally used in differential Auger work.

A button marked 'OSC' on the front panel switches on and off the internal oscillator of the Brookdeal lock-in amplifier.

OPERATION

For initial tests after first installation and as a check on sensitivity at intervals, the best sample to use is a clean copper surface (argon beam etched) which will give three prominent copper Auger peaks having a main peak at 918 eV and probably showing traces of oxygen at 509eV with carbon at 262eV. A spectrum obtained during tests of the optic at the factory is included with this documentation and should be used as a rough guide to expected performance.

The LEG24 electron gun has been designed for small size as a priority and although it will run at 3keV after proper high voltage conditioning it may be advantageous to operate at a maximum of 2.5keV for initial testing and alignment of the optics to avoid occasional sparking. 3KV RANGE.

Having selected the Auger mode, set the beam current to a convenient value, say 50 microamps. switch the DPM on the 8011 to 'AUX' so that it now displays the spectrometer energy. The start/reset sweep switch should be in the reset position. Using the pedestal controls of the spectrometer control unit, set an initial energy of 1000 eV.

The lock-in amplifier controls should be set as follows: Select F2 for derivative spectrum and time constant 300ms. The oscillator button should be in, thus turning on the internal oscillator. Turn the amplitude knob fully clockwise. (For normal operation, the amplitude should be between 10 and 15 Volts p-p). Any phase setting will suffice to begin. Check that at the rear of the unit the oscillator frequency is set to f1 and the reference input is grounded with the mode set to auto.

For initial alignment, an oscilloscope may be coupled to the pre-amplifier output and the signal observed directly to detect the Auger signal. Adjustments to the sample position can now be made for maximum response and the optimum phase setting for the brrokdeal located approximately

The spectrometer control sweep switch should now be set to 'start' and a spectrum will be drawn by the chart recorder.

The phase setting of the lock-in amplifier and the gun focus may now be optimised by repeated scans over the main peak of the spectrum while adjusting these controls.

An alternative method of testing which may be of use where difficulty is encountered in setting up for the first time is to try to detect the elatically scattered electrons at a gun energy setting of about 1000 eV. This signal will be very intense and is more likely to be detected than Auger peaks when the system is badly out of alignment.

The noise visible on the spectrum may be reduced by using a longer time constant in conjunction with a longer scan time.

The gain of the system is related to the modulation amplitude but the noise level is constant so that as the modulation is increased, the signal to noise ratio will improve. Conversely, as the modulation level is increased, the resolution of the spectrum will deteriorate.

FIRST DERIVATIVE SPECTRUM

The signal detected by the optic is in fact the integral of the electron energy spectrum, being the sum of all electron energies above the retard voltage. Normally this signal is differentiated twice to produce an output on the chart recorder in the form known as a 'differential spectrum'. However it is possible to differentiate only once, thereby producing a normal energy spectrum.

In order to do this, it is necessary to detect the fundamental frequency of the modulation. It is not possible to halve the detection frequency of the pre-amplifier, but it is possible to double the modulation frequency by switching at the rear panel of the lock-in amplifier to f2. This has essentially the same effect except that the degree of undesirable capacitive feedback in the system will be different at the new frequency so that it will be necessary to make adjustments to the pre-amplifier nulling controls.

APPENDIX

BNC 'T'

A BNC 'T' connector is supplied with the 8011 in some cases. This is provided so that the user may connect two meshes to a particular socket at the rear of the 8011, usually this is required to connect more than one mesh to the earth socket.

Changes

a) Very early versions of the LEED optic operating instructions used a confusing nomenclature when referring to the LEED optic meshes. The term 'grid' was used instead of 'mesh'. Also, the wehnelt in the electron gun was referred to as the grid. (This is derived historically from the 'grid' in a triode valve) The wehnelt was therefore called 'grid 1' (G1) and the meshes were labelled Grid 2,3 and 4. These correspond to Mesh 1,2 and 3 in this manual.

b) Some 8011 units have been produced with a small error in the rear panel labelling. The socket which should be marked A5 has been labelled A4.

TRT II 43545

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LEED OPTIC TEST CERTIFICATE

W. Order .....

Date 13/5/92

Engineer .....

Serial No. 110

Vacuum Pressure 3×10^{-9} mB

Target current at 100V beam energy 5.6 μA

Filament current 2.9 A

Diffraction pattern on copper sample performance at 55eV PASS/FAIL

No. of Grids 4

Grid cut-off satisfactory PASS/FAIL

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FISONS Instruments

54x50x70 cm
24 Kilos

520022

SHIPPING CHECKLIST FINAL TEST & QA

REPAIR

TO BE COMPLETED IMMEDIATELY PRIOR TO SHIPMENT

CUSTOMER: CALTECH ORDER NO: 520022 DATE: 15/5/92

CONFIGURATOR SURFACE SCIENCE	PRODUCT NUMBER	SERIAL NUMBER	COMMENTS
	LEG24	110	
	HA001		

FINAL TEST ENGINEER _____

FINAL TEST MANAGER _____ QA MANAGER _____

FISONS Instruments

VG MICROTECH

PACKING LIST

Invoice No. : 12693

Page : 1

VG Microtech., Bellbrook Business Park, Bell Lane, Uckfield, East Sussex TN22 1QZ, U.K.
Tel.: (0825) 761077 Telex: 957603 Fax: 44 825 768343

Invoice To:

HELEN J BARKER
FISONS INSTRUMENTS INC
PO BOX 1409, 355 SHOREWAY ROAD
SAN CARLOS, CA 94070
USA

Deliver To:

Date : 18.05.92

Account No. : 243003

Your Ref. :

Our Ref. : 520022

WARRANTY REPAIR
Terms of Payment : BY LAST DAY OF MONTH FOLLOWING DATE OF INVOICE UNLESS LETTER OF CREDIT OR GROUP
Terms of Delivery : EX FACTORY Delivery Method : AIR FREIGHT

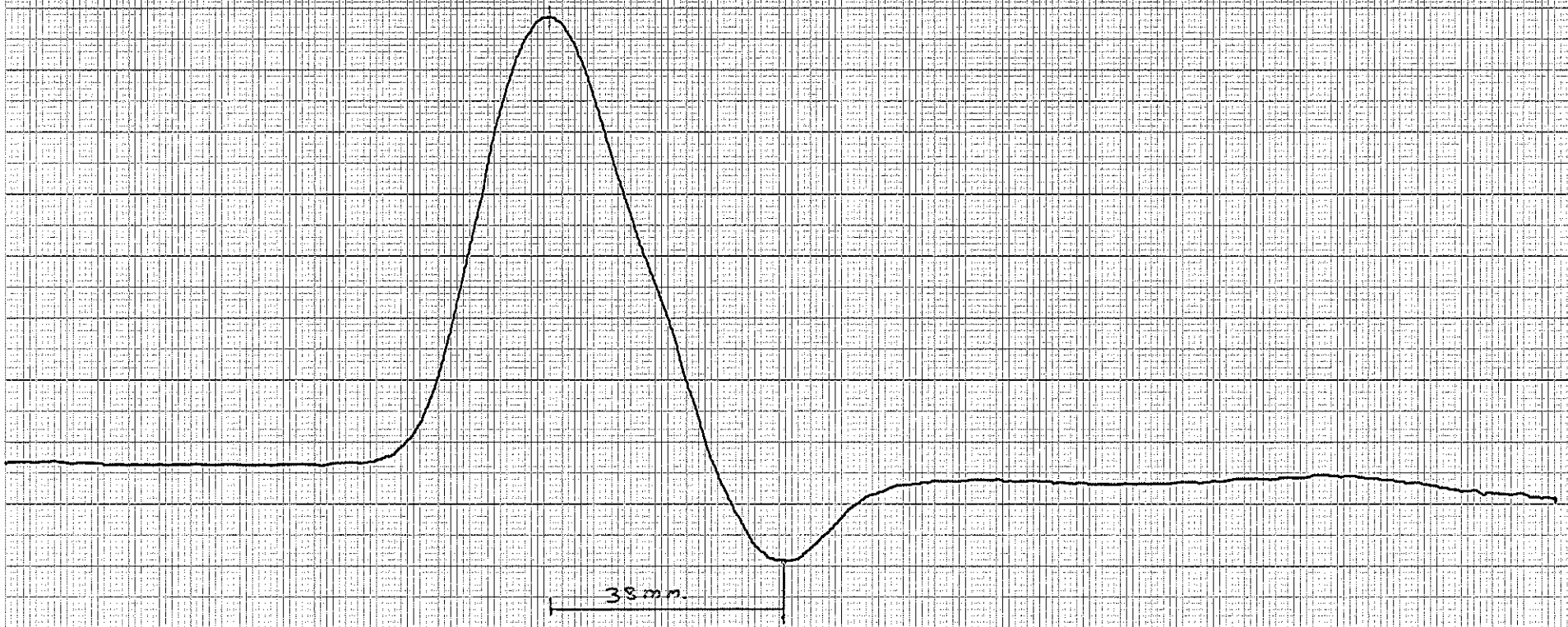
Item	Article No.	Description	Qty.
1	M520022	REPAIR/FINA/CALTECH LEG24 SERIAL NO. 110 VALUE FOR CUSTOMS PURPOSES ONLY: US$12,70	1

WE HEREBY CERTIFY THESE GOODS TO BE OF UK ORIGIN AND MANUFACTURE.

100 V elastic peak

5 V modulation LEC 24-110.

30 V SCAN



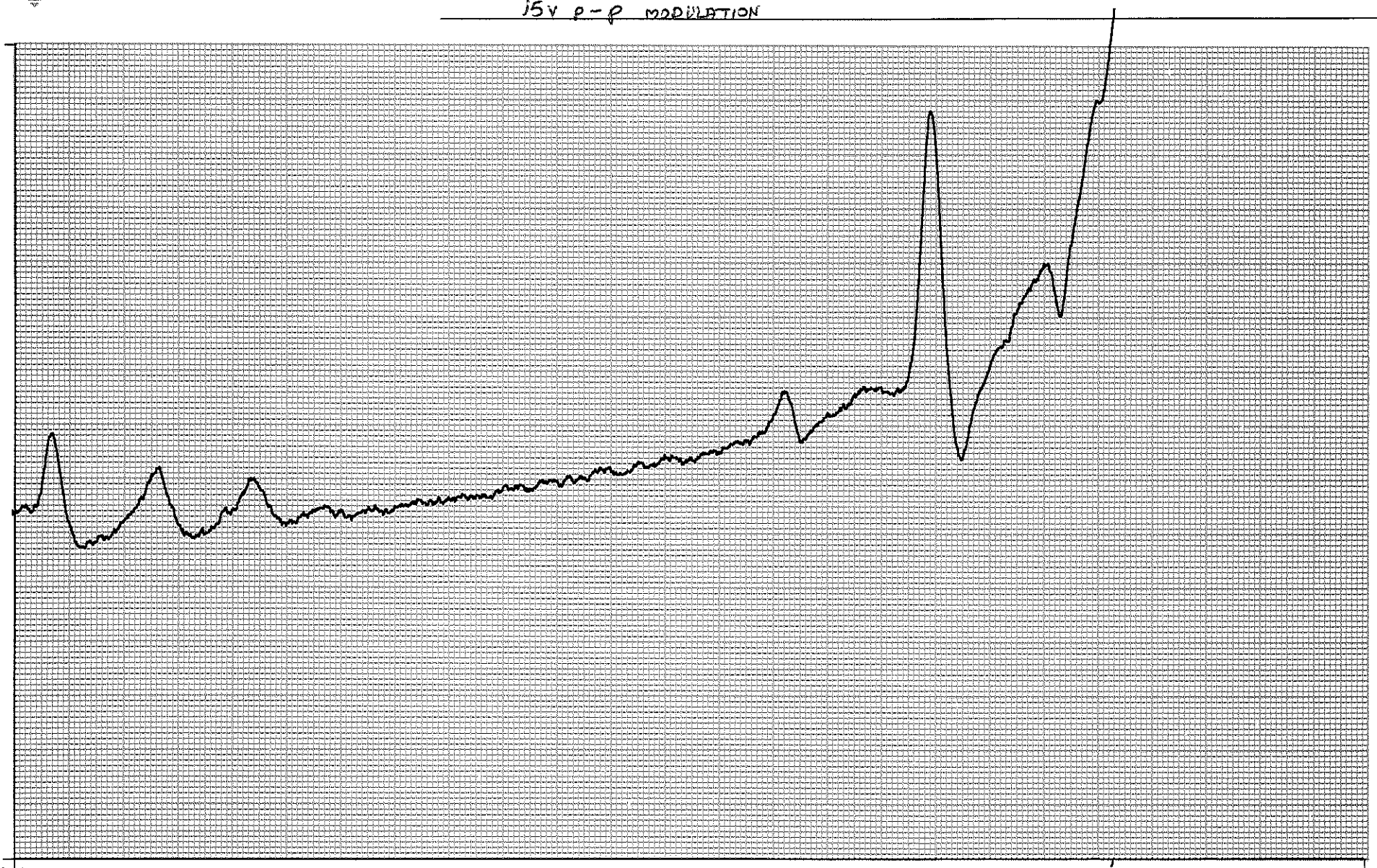
0·456 %

VG MICROTECH

Date 26.11.91.

Analyser LEG-2 110
Source 2.5 kev BEAM
Voltage
Comments 60 μA TARGET CURRENT
15v p-p MODULATION

Scan Time
Time Constant
Pass Energy
Slits



COUNT RATE

ENERGY

FISONS Instruments

54x50x70 cm
24 kg/cos

REPAIR

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CUSTOMER: CALTECH ORDER NO: 520022 DATE: 15/5/92

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FINAL TEST ENGINEER _____

FINAL TEST MANAGER _____ QA MANAGER _____

LEED application note

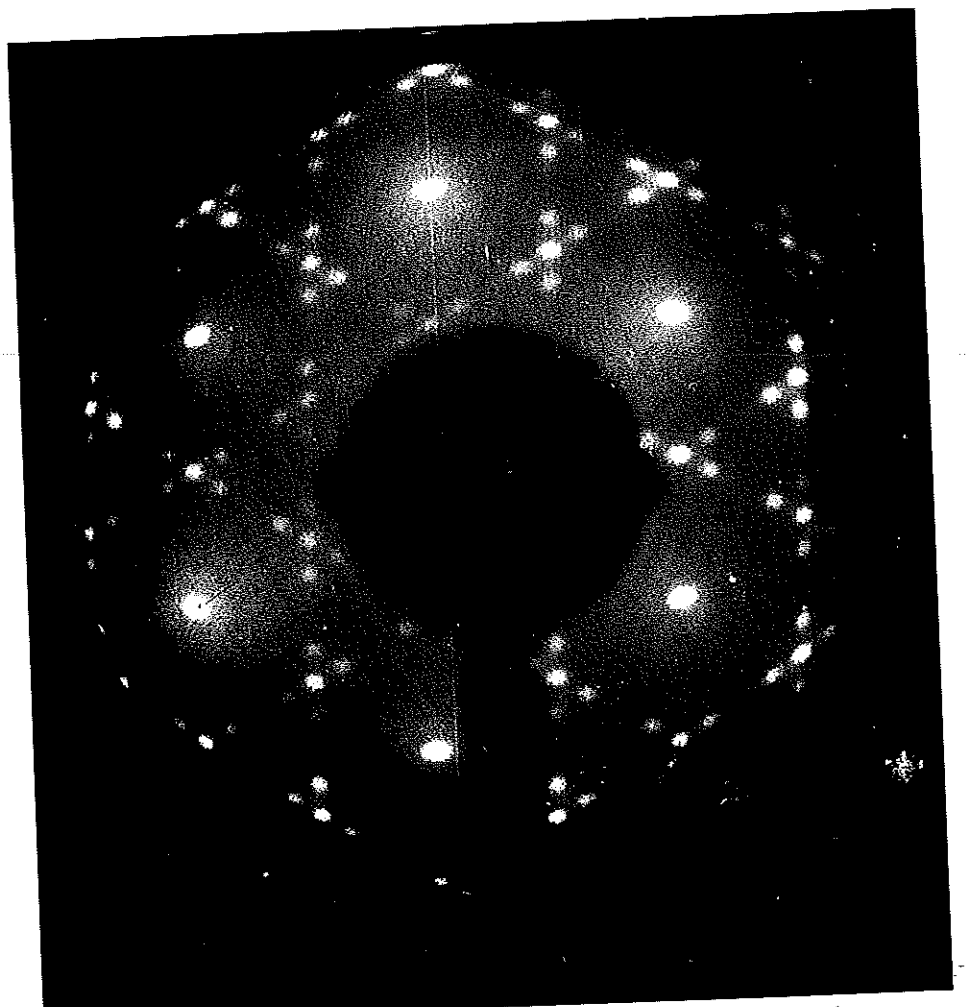
Structural analysis of semiconductors

Low Energy Electron Diffraction (LEED) has applications to the research and development of low temperature semiconductor devices.

In their studies on the surface conductivity of semiconductors at low temperature, the Physics Department at the University of Sussex are using a VG Microtech reverse view LEED apparatus to characterise surface structure.

The photographs overleaf show LEED patterns obtained from germanium as silver is deposited on the surface. The LEED patterns show changes in the surface structure as the amount of deposited silver is increased from zero to two thirds of a monolayer. This information will be used in proposing a mechanism for the changes in conductivity which have been observed.

The VG Microtech reverse view LEED system greatly exceeds the performance of conventional front-view optics. The miniature electron gun and high transparency screen result in a small gun shadow and a good quality optical image of the diffraction pattern. The geometry is particularly suitable for large specimens because the specimen does not obscure the image.



LEED pattern of the germanium (111) surface, after cleaning and annealing at 650°C, showing the Ge (111) 2 × 8 structure.

VG MICROTECH

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LEED OPTIC TEST CERTIFICATE

W. Order ....3157J....

Date ....29.11.91....

Engineer ....P. DAVIES....

Serial No. ....LEG-24-110....

Vacuum Pressure ....2×10^{-9} mB....

Target current at 100V beam energy ....> 2 μA....

Filament current ....2.7 A....

Diffraction pattern on copper sample performance at 55eV PASS/FAIL

No. of Grids ....4....

Grid cut-off satisfactory PASS/~~FAIL~~

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