

# ELECTRA/SELECTRA

*Ratemeter*

## *Operators Manual*

*March 2004*



# RATEMETER TYPE ELECTRA & SELECTRA

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01.03.04

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## **DRAWINGS**

GENERAL ASSEMBLY

E38718/A, B & C

OUTLINE DRAWING

C38719

# 1. INTRODUCTION

The ELECTRA is a portable ratemeter for use with a variety of GM and Scintillation probes for the measurement of Radioactive Contamination and Radiation.

The SELECTRA is a portable ratemeter derived from the ELECTRA, dedicated for use with the Thermo Electron range of 'intelligent' GM and Scintillation 'I' series probes for the measurement of Radioactive Contamination and Radiation.

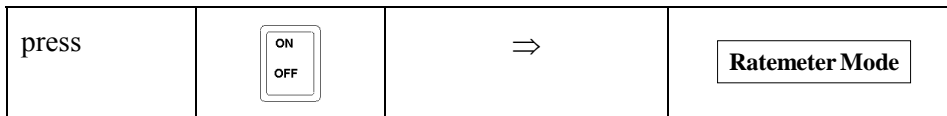
Upon connection of a suitable 'I' series probe, the SELECTRA will interrogate the probe's on-board memory store containing the probe's operating parameters and overwrite the SELECTRA SET UP parameters with these values/options. This enables the SELECTRA-probe combination to commence monitoring immediately without the need to reset the SET UP parameters for the probe required.

The SELECTRA has been designed to provide accuracy in the lower level discriminator and high voltage settings. This accuracy enhances consistency between the performance of SELECTRA (and ELECTRA) units. This consistency implies that 'I' series probes can be interchanged between any number of SELECTRA units without variation in probe performance.

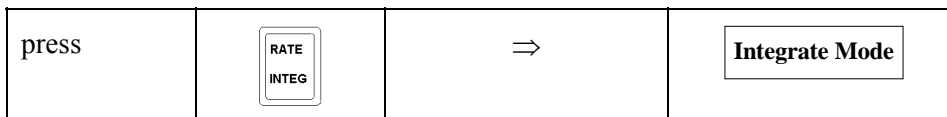
## 1.1 GETTING STARTED: QUICK OPERATION GUIDE

The following is a brief guide only; full details of operational modes can be found in section 4.

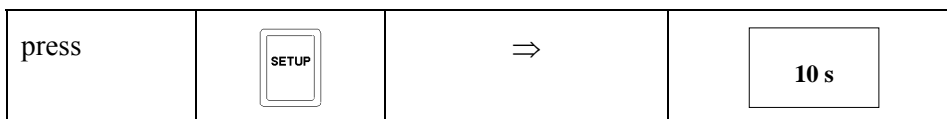
### 1.1.1 Switch - on



### 1.1.2 Rate → Integrate

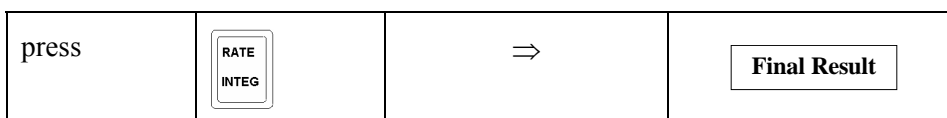


To see elapsed time:




(This feature toggles with the integrate count).










To stop integration:








### 1.1.3 Integrate → Rate

press		⇒	<b>Ratemeter Mode</b>
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
### 1.1.4 Modify Parameters

First	press		⇒	<b>Parameter List</b>
then use	 / 	to find the parameter	⇒	<b>3</b>
then	press		Parameter flashes to show edit mode	
then use	 / 	to select the required value	⇒	<b>19.50</b>
then	press		new value registered	<b>3</b>
finally	press		for change to take effect	<b>Ratemeter Mode</b>

### 1.1.5 Other Functions

	stores background	at any time during ratemeter mode	or	at the end of integration
	toggles to enable / disable sound		and	mutes alarm sound temporarily
	changes display and sound of incoming particles	from $\alpha$ to $\beta$ to $\alpha + \beta$	or	Displays integrated dose for Geiger probes
	provides backlight	one press gives 30 seconds	or	three quick presses for continuous operation
	inhibits changes to parameters	use within parameter list view		

### 1.1.6 Switch - off

press		⇒	unit off
-------	---	---	----------

## 1.2 BASIC DESCRIPTION

The unit consists of two circuit boards, an HV/Amplifier board and a Processor and Interface board, housed in a painted rectangular section aluminium extrusion. Two end plates hold the boards in place and locate the battery holder. A further two plastic end caps prevent unauthorised adjustment of the internal switches, adjustment of the sounder audible level and interference with the power sources available. The LCD display is positioned upon the processor board and is visible through a screen on the top panel of the extrusion. The handle, also positioned on the top panel of the extrusion, provides ease of use even with protective gloves.

Probes can be connected to the unit via a connector attached to the HV/Amplifier board and protruding at the far end of the unit from the handle.

Operation of the unit and entry of setup parameters can be performed via a membrane keypad on the top panel; audible feedback is provided to ensure correct keying even with heavy protective clothing; the membrane keys are also embossed, having a tactile feel.

Display of measured rate is in both analogue and digital formats on a high contrast LCD. The display is auto ranging and capable of displaying Counts per second or Counts per minute for countrate measurements, Bq, disintegrations per minute (dpm) and Bq/cm<sup>2</sup> for contamination measurements or sieverts per hour or roentgens per hour or grays per hour, with the appropriate probes, for doserate measurement. The analogue display is in the form of a bargraph which has a logarithmic scale covering three decades with autoranging to accommodate two further decades. The display has a backlight for use in low light conditions, which is operated by a key on the front panel.

Audible indication of measured rate is given by an internal sounder and an external socket is provided at the handle end to enable the audible output to be transferred to headphones. A pot situated under the outer end cap is available for volume control of the audible output.

Alarms can be given, as a continuous tone on the sounder, and an indication on the display, if the measured rate exceeds a presettable level. The alarm level can be set over a wide range, or disabled, by digital control.

With Thermo Dual Scintillation probes, alpha and beta contamination can be monitored simultaneously, with separate tones on the sounder, and independent alarm levels for each particle type. The display of rate can be selected to be for either type of particle or for the sum of both.

For use with gamma scintillation probes an energy selection facility is available, with an upper threshold which can be adjusted by the user from the keypad.

In GM setting, an integrated dose is performed. This can be viewed during most operations by selecting the channel view button ( $\alpha/\beta$ ).

The required operating modes for use with scintillation or GM based instruments can be set up by the SET UP key on the keypad. Unauthorised adjustment of these parameters can be prevented by selection of an internal switch situated underneath the end cap of the unit.

The instrument normally measures rate, but for more accurate measurement an integrate mode is provided, with presettable integrate times. A background subtraction facility is provided which can be activated or deactivated from the keypad.

Battery backup of all entered parameters and alarm levels is maintained when the batteries are removed. The instrument is prevented from rate measurement should the parameters become corrupted due to failure of the backup battery.

The unit is powered by three standard 'C' size cells of either Primary or rechargeable type. Rechargeable cells may be recharged in the unit by means of an optional mains operated charger which can be connected via a socket in the end of the unit. The charger unit also doubles as a DC supply, which can be used without batteries fitted, if the unit is installed in a fixed position.

A test mode is provided to aid customer testing and error messages are provided in normal use to assist fault finding and diagnosis.

There are two versions of the ELECTRA:

ELECTRA1A is to be fitted with a PET probe connector.

ELECTRA1B is fitted with an MHV connector.

## **2. DETAILED DESCRIPTION**

### **2.1 CASE**

The ELECTRA/SELECTRA case consists of a painted rectangular section aluminium extrusion with two end plates. Two further detachable plastic end covers prevent unauthorised adjustment of internal switches or interference with the power source used. The probe is attached via a coaxial cable to a PET or MHV connector which protrudes through one end cap.

The unit is fitted with a handle enabling the display to be easily read whilst the instrument is hand held. The display end of the unit houses the HV connector and DC input for the charger/mains supply. The handle end of the unit houses the battery compartment entrance, an external audio output for use with headphones, the audible level control pot and the internal security switches, S1. Once the protective end cover at the handle end of the unit is in place, only the battery compartment and headphone input are accessible.

A description of the unit parameters is displayed on the side of the extrusion.

The top panel of the ELECTRA/SELECTRA contains a flush fitting membrane panel with ten keys for operating the instrument. The high contrast Liquid Crystal Display (LCD) is capable of displaying in both analogue and digital formats. It can also show the units of measurement for the application and warning and information symbols. The display is viewed through a window in the membrane panel.

Access to the battery compartment is through a cut out in the end cover below the handle. If rechargeable cells are used, access to the batteries may be prevented by the insertion of a plug in this cut out. When dry cells are used a similar plug should be placed in the end cover at the display end of the unit preventing connection of the charger socket.

The loudspeaker is positioned alongside the battery compartment facing the side of the unit and a variable output can be obtained by use of a pot, situated in the handle end of the unit.

### **2.2 ELECTRONICS**

The ELECTRA/SELECTRA electronic components are mounted on two circuit boards, designated the HV/Amplifier Board type 5460 and Processor and Interface Board type 5461, which are interconnected by 2 cables.

#### **2.2.1 Processor and Interface Board type 5461**

The Processor Board is mounted horizontally just below the top surface of the unit and is held in the grooves of the extruded housing. The Processor Board contains a microprocessor which controls the operation of the instrument, counts the incoming pulses from the HV/Amplifier Board and drives the display, which is also mounted on the board.

A flexible cable connects the front panel key pad to the Processor Board to control the operation of the instrument. The layout of the keypad is shown in an illustration at the back of this manual.



## 2.2.2 HV/Amplifier Board type 5460

The HV/Amplifier Board is positioned below the Processor Board (the boards are separated by the battery compartment), and provides the High Voltage supply for the probe with overload protection, a charge sensitive pulse shaping amplifier, discriminators and amplitude selection circuits. The upper level threshold discriminators, the HV supply and overload current are controlled digitally from the keypad. The mode of the amplitude selection circuitry (GM or Scintillation) is also controlled from the keypad. Power for this board is supplied by the Processor Board through the flexible cable which connects the two boards. A PET or MHV connector (5460 A or B version) or a FISCHER connector (5460C) is mounted on a bracket on the end of the board so that it passes through the end cover for connection to the probe.

## 2.3 PROBE CALIBRATION

Set up and calibration of a probe on the ELECTRA can be performed by positioning the internal switch S1-2 to SUPERVISOR (ON) and subsequently determining all the required parameters from unit tests. Once these operating parameters have been determined they can then be entered by the SET UP key. Any new parameter is stored as default upon the ELECTRA once the ENTER key is pressed.

Set up calibration of a probe using the SELECTRA can be performed as above except that the operating parameters entered by the SET UP key are written to the 'I' probe connected. Any new operating parameter is stored as default within the probe once the ENTER key is pressed, providing the probe is connected.

Any changes to the operating parameters under the SET UP key can be inhibited to the user by pressing the INHIBIT (Ø) key when each parameter is displayed and the internal switch is set to SUPERVISOR. If the internal switch S1-2 is subsequently set to USER (OFF), the user will not be allowed to change the inhibited parameter.

The user will also be inhibited from 'programming' the probe connected. If the internal switch is set to USER, any parameter changed by the user will not overwrite the probe memory.

### ***IMPORTANT NOTE:***

***'I' probes can ONLY be connected to a selectra, non-intelligent probes can ONLY be connected to an electra.***

## 2.4 PROBE INTERCHANGEABILITY (SELECTRA ONLY)

Upon connection of a suitable 'I' series probe, the SELECTRA will interrogate the probe's on-board memory store containing the probe's operating parameters and overwrite the SELECTRA SET UP parameters with these values/options. This enables the SELECTRA-probe combination to commence monitoring immediately without the need to reset the SET UP parameters for the probe required.

The SELECTRA has been designed to provide precision in the absolute value of the lower level discriminator and high voltage settings. This precision enhances consistency between the performance of SELECTRA (and ELECTRA) units. This consistency implies that 'I' series probes (with their stored parameters) can be interchanged between any number of SELECTRA units without variation in probe performance.

### **3. SPECIFICATION**

#### **3.1 PERFORMANCE**

##### 3.1.1 High Voltage

Nominal Range 400 V - 1400 V in 5 V steps  
Absolute value  $\pm 2.5$  V

Maximum Load 66 M $\Omega$  + 10  $\mu$ A @ 1400 V  
40  $\mu$ A @ 900 V

##### 3.1.2 Charge Sensitivity

Lower Threshold -  $1.7 \times 10^{-11}$  C (100 mV)  $\pm 1\%$  (FIXED)

Upper Threshold -  $2.6 \times 10^{-11}$  C to  $5.1 \times 10^{-10}$  C  
(150 mV to 3.00 V in 50 mV steps)

Accuracy:  $\pm 1\%$  or  $\pm 15$  mV which ever is the least.

##### 3.1.3 Overload protection

Pre-settable overload protection based on excess current from the High Voltage supply.

Nominal Range 0.00  $\mu$ A to 40.00  $\mu$ A in 0.25  $\mu$ A steps (range dependent on probe type).

##### 3.1.4 Dead time correction

Pre-settable value for dead time correction.

Range 0  $\mu$ s (OFF) to 250  $\mu$ s in 1  $\mu$ s steps.

##### 3.1.5 Response time

#### **AUTOMATIC RESPONSE MODE**

1 second basic counting period, with averaging up to 16 seconds and thereafter a rolling average over 16 seconds is maintained for steady count rates and for count rates below 6 counts per second.

The response time will be less than 2 seconds for significant changes, i.e.  $> 3$  sigma above 6 cps and 11 seconds to 63% for lower rates and for smaller changes.

## PRESET RESPONSE MODE

1 second basic counting period, with averaging up to a presettable period of 1 to 25 seconds and thereafter a rolling average is maintained over this period and the display updated every second.

## INTEGRATE MODE

A separate integrate mode allows integration over a presettable time period in the range 1 s to 5000 s as follows:

1	-	10	seconds in 1 second steps
15	-	30	seconds in 5 second steps
40	-	5000	seconds in 10 second steps

### 3.1.6 Alarm

Alarm level - presettable over defined ranges or OFF

**NOTE:** *If DUAL probe is selected, Alarm levels are available individually for  $\alpha$  and  $\beta$  by selecting the  $\alpha$ ,  $\beta$ ,  $\alpha+\beta$  key.*

Ranges

a)	Countrate	cps:	0.1	to	50,000
		cpm:	1	to	300,000
b)	Contamination	Bq:	0.1	to	50,000
		Bq/cm <sup>2</sup> :	0.1	to	50,000
		dpm:	1	to	300,000
c)	Doserate	Sv/h:	0.01 $\mu$ Sv/h	to	5 Sv/h
		R/h:	1 $\mu$ R	to	500 R/h
		Gy/h:	0.01 $\mu$ Gy/h	to	5 Gy/h
d)	Dose	Sv:	0 $\mu$ Sv	to	5 Sv
		R:	0 $\mu$ R	to	500 R
		Gy:	0 $\mu$ Gy	to	5 Gy

The full scale value may not be reached in all cases due to an Overload condition having been activated (See section 4.2.1.9).

### 3.1.7 Audible Indicator

Single Channel operation: a click for each detected particle.

Dual Probe operation: clicks for each Beta, tone for each Alpha.

Alarm: Continuous tone at a frequency of 1.5 kHz

## 3.2 DISPLAY

### 3.2.1 Displayed Characters

The Liquid Crystal display provides analogue and digital indication of measurement result, unit of measurement and operational indicators.

#### ANALOGUE

Analogue 3 decade logarithmic bargraph, with scale markers at:

1, 1.2, 1.4, 1.6, 1.8, 2, 3, 4, 5, 6, 7, 8, 9 .and numerical indicators for 1, 2, 5 for each decade.

Bars are logarithmically spaced to match the scale marks and additional bars are provided for 2.25, 2.5, 3.5, 4.5.

The bar will be black to the mark below the true value.

Resolution 20% or better.

The display allows numerical ranges: 0.1-100, 1-1000 & 10-10,000.

The display will auto range and changes by one decade at each change, with change of units, if required.

#### DIGITAL

4 digits with 3 decimal points, show the measured rate to 3 significant digits. Actual displayed values on each of the ranges are limited by the range changing and software but the display limits are 0.01 - 99.9, 0.1 - 999, 1.0 – 9990.

#### UNIT OF MEASUREMENT

Countrate Monitoring	-	cps, cpm, kcps, kcpm
Contamination Monitoring	-	Bq, dpm (disintegrations per minute), Bq/cm <sup>2</sup> with prefixes of k.
Radiation Measurement	-	R/h, Sv/h or Gy/h with prefixes of n, μ, m, k.

The range and units displayed will be dependent on the probe used and are set by the SET UP parameters.

#### VOLTAGE

Measurements are displayed, with the same numerical ranges as detailed above, on the digital scale in units of volts, with a step size of 5 V for HV.

## OPERATIONAL INDICATORS

Sounder On	A sounder symbol is displayed.
Battery Low	A battery symbol is displayed when the battery voltage drops below a nominal 3.4 volts. Only 8 hours usage will be available once the symbol first appears.
Inhibit	An inhibit symbol is displayed if a parameter under the SET UP key is inhibited to the USER.
Set up Mode Number/Alarm	A 7 segment indicator shows the set up mode number and displays A in alarm condition in normal operation.
$\alpha$ , $\beta$ , $\alpha+\beta$	Shows which particle type is being displayed in the Dual Probe mode only.

### 3.2.2 Display Illumination

A backlight is provided for the display which allows it to be read in low levels of illumination. The backlight stays on for 30 seconds after pressing the key. Three presses of the key in quick succession will enable the backlight to remain fully on indefinitely until the backlight key is pressed again.

### 3.2.3 Ranges

The range tables given in section 3.2.3.1 shows the decade marks for the analogue display. The digital display gives one decade lower reading, i.e. 0.01 for 0.1 and up to 1 below full scale.

#### 3.2.3.1 Ranges for Countrate Probes

##### CPS selected

Range 1	0.1	-	1	-	10	-	100	cps
Range 2	1	-	10	-	100	-	1,000	cps
Range 3	10	-	100	-	1,000	-	10,000	cps
Range 4	0.1	-	1	-	10	-	100	kcps

##### CPM selected

Range 1	1	-	10	-	100	-	1,000	cpm
Range 2	10	-	100	-	1,000	-	10,000	cpm
Range 3	0.1	-	1	-	10	-	100	kcpm
Range 4	1	-	10	-	100	-	1,000	kcpm

**NOTE:** On increasing counts the display range will change up by one decade when any number to be displayed exceeds the full scale value. On decreasing counts the change will occur if the count for display is less than 1/100 of full scale.

### 3.2.3.2 Response Factor (Calibration Factor) Ranges

The instrument can be set to display the following units:

- a) Bq
- b) dpm (disintegrations per minute)
- c) Bq/cm<sup>2</sup>
- d) Sv/h
- e) R/h
- f) Gy/h

The ranges available will depend upon the response factor set (parameter 9) and the range of countrate as detailed in section 3.2.3.1 above.

Response Factors for converting countrate to other units for any probe are as follows:

Unit of Measurement	Ranges of Adjustment			Unit of Response Factor
Bq	0.001	-	1.000	cps/Bq
dpm	0.001	-	1.000	cpm/dpm
Bq/cm <sup>2</sup>	0.01	-	999	cps/(Bq/cm <sup>2</sup> )
Sv/h	0.001	-	99.9	cps/( $\mu$ Sv/h)
R/h	0.01	-	999	cps/(mR/h)
Gy/h	0.001	-	99.9	cps/( $\mu$ Gy/h)

These response factors can be set whilst the instrument displays 9 in the SET UP parameters (providing the UNIT parameter, 8, has been set to the unit required).

**NOTE:** *The response factors entered for cps/Bq and cpm/dpm, as Parameter 9, are analogous to the 4 $\pi$  probe efficiency to the isotope of interest as a fraction of unity. cps/(Bq/cm<sup>2</sup>) is analogous to the 4 $\pi$  probe efficiency to the isotope of interest as a fraction of unity multiplied by the sensitive area of the probe.*

### 3.3 CONTROL

#### 3.3.1 Operational Keypad

Location - Top Panel

Type - Pressure sensitive switches, embossed and tactile.

KEY MARKING	FUNCTION
ON/OFF	Toggles the Instrument On/Off
$\alpha$ , $\beta$ , $\alpha+\beta$	Selects the Alpha, Beta or Alpha+Beta particle countrate for display in the Dual mode only.
Sounder symbol	Toggles the sounder On/Off
Lamp symbol	Switches the Backlight On for 30 seconds or if pressed three times in quick succession will activate the backlight indefinitely until the key is pressed again.
RATE INTEG	Toggles the operational mode between Rate and Integrate.
SET UP	Sets the instrument into the condition to view and adjust, if enabled, a number of parameters. These are shown in the table on the next page.
Inhibit symbol	Indicates to the USER that a parameter is inhibited under the SET UP key.
ENTER	Allows access and storage of the parameters under the SET UP key. Allows storage and clearing of the value to be used for background subtraction.
▲	Allows the digitally controlled parameters to be incremented. Also allows scrolling up through the parameters under the SET UP key.
▼	Allows the digitally controlled parameters to be decremented. Also allows scrolling down through the parameters under the SET UP key.

SET UP - Parameters that can be set, or viewed using the SET UP key are:

No.	Parameter	Digital Display	Unit
0	Battery voltage	battery volts	V
1	Alarm level ( $\alpha$ , $\beta$ , $\alpha+\beta$ )	alarm countrate, contamination or doserate or OFF	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h
2	Stored background ( $\alpha$ , $\beta$ , $\alpha+\beta$ )	background countrate or doserate	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h
3	High voltage setting	HV setting	V
4	Overload current	overload current	$\mu$ A
5	Deadtime	deadtime	$\mu$ s
6	Upper Level Discriminator	threshold voltage	V
7	Integrate Time	integrate time	s or m
8	Units	Unit	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h
9	Response factor	See section 3.2.3.2	
A	Inhibit background subtraction	on or oFF	
b	Inhibit integrate facility	on or oFF	
C	Rate monitoring algorithm	PrES or Auto	
d	Preset response time	response time	s
E	Pulse counting mode	int or diff or dUAL	
F	GM or Scintillation (66 M $\Omega$ chain or 120 M $\Omega$ chain)	G or S66 or S120	
n	Auto switch-off	Off, 1-30	min
SELECTRA only:			
G	Probe type number		
H	Probe Serial number		

All the above options are explained in Section 4.2.



### 3.3.2 Switches

Type - 4 way dual in line package.

Located on Digital Board

No.	Function	ON	OFF
1	ELECTRA/SELECTRA selection	SELECTRA	ELECTRA
2	SUPERVISOR/USER mode. Security switch to allow the SUPERVISOR to change any parameter or to inhibit any parameter to the USER (See Section 5.2.1). If USER is selected, only the parameters not inhibited by the SUPERVISOR can be altered.	SUPERVISOR	USER
3	HIDE/SHOW mode. If the switch is set to HIDE, all the inhibited parameters set by the SUPERVISOR are hidden from the USER and do not appear upon the display in USER mode.  SHOW will allow viewing of all parameters.	HIDE	SHOW
4	TEST mode. Allows the SUPERVISOR to initiate a series of unit tests (See Section 6.1).	ENABLED	DISABLED

**NOTE:** *The unit must be switched OFF and then ON for any change in the switch settings to be registered. These switches are not accessible to the operator once the protective end cap is fitted.*

### 3.3.3 Potentiometers Location - Digital Board

Horizontal Triangle: Volume for Sounder and Headphones accessible through the end cap of the unit.

This potentiometer is not accessible to the operator once the protective end cap is fitted.

### 3.4 CONNECTORS

Function			Type
Signal	ELECTRA	A Version	PET Coaxial Socket
		B Version	MHV Coaxial Socket
Headphones	SELECTRA		FISCHER 7 way socket
			3.5 mm Stereo Jack Socket
DC Input/Battery Charger			2.5 mm Power Socket

**NOTE:** *The headphone socket will always be accessible to the operator even if the protective end cap is fitted. The charger socket is located at the display end of the unit, next to the probe connector.*

### 3.5 POWER SUPPLY

The unit may be powered by Primary Cells, Rechargeable Cells, or from a DC supply.

#### 3.5.1 Primary Cells

Type	IEC LR14
Quantity	3
Life at 20°C	> 90 hours at 4 hours/day with sounder off with Alkaline manganese cells, for a typical Scintillation probe. The capacity of these batteries is reduced at low temperatures and are not recommended for use below -15°C

#### 3.5.2 Rechargeable

Type	IEC KRH 27/50
Quantity	3
Life at 20°C	>25 hours at 4 hours/day with sounder off with Nickel Cadmium cells, for a typical Scintillation probe.

#### 3.5.3 DC supply

Voltage	4.75 V to 5.25 V
Current	250 mA max.

### 3.6 ENVIRONMENTAL

Temperature Range	-20 °C to +50 °C
Humidity	Up to 95% non condensing

### 3.7 MECHANICAL (APPROXIMATE DIMENSIONS)

Length	250 mm
Width	110 mm
Height	71 mm minimum (135 mm including handle)
Weight	1.22 kg (excluding batteries)

### 3.8 OPTIONAL EXTRAS

#### 3.8.1 Power Sources

<b>Part No.</b>	<b>Description</b>
AE0064A	3 Dry Cells - Alkaline Manganese
AE0065A	3 Rechargeable Ni Cad C cells Charger/Mains supply with moulded on 13 A UK Plug to BS 1363 Mains Input - 230 V / 50 Hz Output +5 V at 250 mA max
AE0066A	3 Rechargeable Ni Cad C cells Charger/Mains supply with moulded on 2 pin USA plug to UL 1310 Mains Input - 120 V / 60 Hz Output +5 V at 250 mA max.
AE0067A	3 Rechargeable Ni Cad C cells Charger/Mains supply with moulded on 2 pin EURO plug to DIN 49464 Mains Input - 230 V / 50 Hz Output +5 V at 250 mA max.
AE0109A	3 Rechargeable Ni Cad C cells Charger/Mains supply with 2m flying lead Mains input - 110 V/50-60 Hz Output +5 V at 250 mA max.
AE 0114A	3 Rechargeable Ni Cad C cells Charger/Mains supply with 2m flying lead Mains input 230 V/50-60 Hz Output +5 V at 250 mA max

#### Mechanical details - chargers

Length:	96 mm
Width:	58 mm
Depth:	

Part Number	Depth Excluding pins	Depth Overall
AE0065A	58 mm	81 mm
AE0066A	55 mm	72 mm
AE0067A	48 mm	86 mm
AE0109A	48 mm	----
AE0114A	48 mm	----

Weight: 430 g

### 3.8.2 Standard Probe Cables

'Curly'	Cable Range
3190A	MHV - MHV
3191A	MHV - PET
3192A	MHV - BNC
3201A	PET - PET
3203A	PET - BNC

'Straight'	Cable Range: all 1.5 m (other lengths available)
3152F	PET - PET
3206A	MHV - MHV
3211A	MHV - PET

**WARNING:** *Curly cables 3190A - 3192A, 3201A, 3203A may not provide adequate protection against EMC.*

### 3.8.3 'Intelligent Probe' cables

3209	Extension cable for probes with integral 1m cable
3212	Light weight, flexible 'EMC' cable for use with 'CE' marked Selectra only.
3213	Original cable for use with 'non' CE marked Selectra only.

**WARNING:** *Probes with integral cables, 3209 extension cables and 3213 cables may not provide adequate protection against EMC.*

### 3.8.4 Probe Holders

AE0089A	DP6 style
AE0094A	DP3 style
AE0095A	DP2 or BP4 style
AE0133A	Low profile, for many probe types.

### 3.8.5 Belt Holder: suitable for attaching Electra plus AE0089A to a belt

AE0106A	for 2" belts
AE0106B	for 2½" belts

## **4. OPERATING FUNCTIONS**

### **4.1 POWER SOURCES**

#### **4.1.1 Dry Cells**

The ELECTRA/SELECTRA is powered by three C size cells fitted into the battery holder at the handle end of the unit. The battery holder cap can be removed by unscrewing the cap anticlockwise. The batteries must be inserted with correct orientation as indicated on the side of the ELECTRA case. The battery holder is spring loaded such that once the battery holder cap is secured, movement of the batteries is prevented.

If dry cells are fitted, access to the charger socket **MUST** be prevented by covering the socket with the end cover plug provided. The unit is factory supplied with this plug fitted.

#### **4.1.2 Rechargeable Cells**

Rechargeable C size cells are loaded as described for the dry cells above. These cells may be recharged by connection of the optional battery charger / DC power source (See Section 3.8.1) in the charger socket at the display end of the unit.

#### **4.1.3 DC Supply**

The optional charger can be used as a DC supply if plugged into the charger socket at the display end of the unit. All dry cell batteries must be removed.

#### **4.1.4 Battery Low Symbol**

The battery low symbol will appear along the bottom of the display to indicate that only 8 hours of use is left. The batteries must be replaced as soon as possible once this symbol appears.

## 4.2 FUNCTIONAL OPERATION

The functional operation of the ELECTRA/SELECTRA can be divided into two sections:

- 1) Monitoring mode
- 2) Parameter set up mode

### 4.2.1 Monitoring Mode

#### 4.2.1.1 *Switch-On*

The ON/OFF key is the top left of the keys upon the front panel.

When the ELECTRA is switched ON the unit will perform a display test with all LCD segments lit. After a few seconds, when the unit has performed its self checks, the display will revert to normal RATE monitoring mode in the units selected prior to switch off.

When the SELECTRA is switched ON **and** a probe is connected, the unit will additionally beep and display the probe generic type, i.e. if IDP6A is connected the display will show 'DP6'. After displaying the probe type for one second the unit will display ----- and the unit parameter stored within the probe. The inhibit symbol and bargraph is also displayed.

After a few seconds, when the HV is stabilised, the display will revert to normal RATE monitoring mode.

#### **IMPORTANT NOTE (SELECTRA ONLY)**

*If no probe is connected, the unit will display **Err d** (see section 6.2) and will not be operational until a relevant probe is connected.*

#### 4.2.1.2 *Ratemeter Mode (RATE)*

When this option is selected the display will show the units appropriate to the operational state set under the SET UP key. After switch ON, the unit will perform its self checks and after a few seconds will revert to normal RATE monitoring mode. After a second of monitoring in RATE mode, the ELECTRA/SELECTRA will display the rate, corrected for deadtime, in the units selected. It will continue to display rate with the value being updated at one second intervals.

Two options of rate averaging are available in this mode:

- a) In the PRESET response time mode, the average rate over the time from start will be displayed until the preset averaging period is reached. Thereafter a rolling average will be displayed over this period. The time period is preset by the user.
- b) In the AUTOMATIC response time mode, the averaging time is 16 seconds and the response to steady signals and to rates below 6 cps is the same as for a preset response time of 16 seconds. However, in this mode, if the measured rate in any one second period differs by more than 3 standard deviations from the displayed rate, then the value measured in the last second will be displayed and the integration up to 16 seconds is restarted. This mode gives rapid response to significant changes, whilst maintaining the 16 second integration to reduce the statistical fluctuations for steady signals.

In RATE mode, the analogue bargraph will display the measured rate after correction for deadtime. If the rate increases above the full scale of the analogue bargraph, then the scale will change up one decade to accommodate the higher reading. Should the measured rate decrease into the lowest decade of the scale, then the scale will step down one decade. The user will be alerted to a change in scale by a short, high pitched tone from the speaker.

The 4 digit digital section of the display will show the measured rate in the selected units, to three significant figures of accuracy. Both the analogue and digital displays are updated once a second with the new measured rate.

#### 4.2.1.3 *Integrate Mode (INTEG)*

If more accurate rate measurements are required, the ELECTRA/SELECTRA may be used in integrate mode. Integrate mode is entered by pressing the RATE INTEG key whilst the instrument is operating in rate mode (providing the Inhibit Integrate, Parameter b, is OFF). When this mode is selected the instrument starts a count over a preselected time period. After each second the digital display will show the mean count rate from the initiation of measurement. The analogue bargraph and scale will not be activated.

Whilst the unit is in the integrate mode the elapsed time in seconds may be displayed by pressing the SET UP key. A further press of the SET UP key will revert the display to the mean count rate.

The integral count will stop at the end of the preset time, or may be terminated prematurely by pressing the RATE INTEG key. When stopped the instrument will emit a short tone and will display the mean count rate over the measurement period. Subsequent presses of the SET UP key will allow the display to toggle between the duration of the measurement and the mean count rate.

Once the Integrate measurement has terminated, the unit is returned to the ratemeter mode by pressing the RATE INTEG key again.

#### 4.2.1.4 *Sounder Operation*

Whilst the ELECTRA/SELECTRA is monitoring in ratemeter or integrate modes, incoming radiation will cause a click for each detected event. If operating in dual channel mode then an event in the Alpha channel will cause a short, low pitched tone.

If the unit is to be operated in a high ambient noise environment, then standard “personal stereo” type headphones with a 3.5 mm jack plug may be plugged into the headphone socket located at the handle end of the unit. When the headphones are connected, the internal speaker is disconnected. The headphone socket is accessible even if the protective end cover is fitted.

The rate indication sounds may be toggled on and off, in either ratemeter or integrate modes, by pressing the Sounder key on the front panel of the instrument. When the sounder is active the sounder symbol at the bottom left of the display is visible.

The volume of the speaker may be adjusted by the internal potentiometer control situated underneath the protective end cover at the handle end of the unit.

#### 4.2.1.5 *Dual Probe Operation*

If the unit is set up for Dual Probe operation, inputs between the lower and the upper thresholds are counted as Beta particles and those above the upper threshold are counted as Alpha particles.

In both ratemeter and integrate modes the display will show either Alpha or Beta counts or their sum, as selected. The particle symbol in the lower right side of the display will indicate the type being displayed. To change the displayed type, press the **α, β α+β** key, then the displayed radiation type will cycle through the sequence Alpha only, Beta only and Alpha plus Beta. The sounder will give **α** and **β** particle sounds depending upon the display selection, i.e. if in **α** mode only, only incident **α** particles will be audible.

#### 4.2.1.6 *Background Subtraction*

In the ratemeter mode the last displayed average rate may be stored as the background rate by pressing the **ENTER** key. The background rate is thereafter subtracted from the measured rate to provide a nett rate for display. When background subtraction is active a 'b' is displayed in the bottom left of the display. The displayed rate can be negative in this mode and in this case a negative sign is shown on the display and the bargraph disappears.

For accurate measurements the background rate should be taken over a long period, and this can best be done in the integrate mode. Pressing **ENTER** at the end of the integrate period will store the required background.

If the ELECTRA/SELECTRA is operating with a Dual Probe then the average rates in both the Alpha and Beta channels are stored.

The current background rate stored by the instrument may be displayed by viewing Parameter 2 under the **SET UP** key. If the instrument is in dual probe operation, pressing the **α, β, α+β** key will display the separate Alpha and Beta background levels.

If the **ENTER** key is pressed again the stored background is reset to zero and normal operation is resumed and 'b' disappears from the display.

The background subtraction operates in the rate and integrate modes but cannot be activated if the inhibit background subtraction is **on** (Parameter A under the SET UP key).

#### 4.2.1.7 *Alarm Operation*

When the ELECTRA/SELECTRA is in the ratemeter mode, the alarm condition will be entered if the mean count rate displayed is above the preset value. The alarm condition is indicated by a continuous, high pitched, tone from the speaker or headphones and 'A' being displayed in the bottom left of the display. If the measured rate drops below the alarm level, the alarm condition ceases.

The alarm sound can be muted by pressing the sounder key, but the displayed 'A' remains as an indication of the alarm condition. Once muted the alarm sound function will be reactivated if the rate increases above the preset alarm level.

If background subtraction is being used, the subtracted rate is compared with the alarm levels.



In Dual Probe operation the Alpha and Beta channels are compared to independent alarm levels, the nett count rate in either channel causing an alarm condition if it exceeds the corresponding alarm level. If an alarm level is exceeded in either the  $\alpha$  or  $\beta$  channel, the relevant  $\alpha$  or  $\beta$  symbol will flash.

The alarm level setting may be viewed or altered by the operator by selecting Parameter 1 under the **SET UP** key. When in dual probe operation the separate alarm levels for Alpha and Beta are displayed by pressing the  $\alpha$ ,  $\beta$ ,  $\alpha+\beta$  key then using the  $\blacktriangle$   $\blacktriangledown$  keys to change the values. The alarm level can be switched OFF if required.

**NOTE:** For *SELECTRA OPERATION*, the pre-set alarm levels are not a function of the probe but depend rather on measurement application and the location of measurement. It is important to check that the alarm settings are valid and relevant for each intended use.

#### 4.2.1.8 Low battery Warning

When the battery voltage level nears the minimum to supply the ELECTRA/SELECTRA the battery warning symbol will be displayed. At this point the instrument should have at least a further eight hours operation under normal usage with Ni-Cad batteries, or longer with dry cells. If the battery level is allowed to drop below the minimum required to operate the ELECTRA/SELECTRA it will automatically switch off.

An internal back up battery will allow the stored digital parameters to be retained after removal of the batteries.

#### 4.2.1.9 Overload

There are three overload conditions which are indicated by a continuous alarm sound and the full analogue bar on the digital display. A small 'o' symbol appears at the bottom left of the display. The sound cannot be inhibited by pressing the **SOUNDER** key. The unit will return to normal measurement when the overload condition no longer exists.

The three conditions are:

##### **HV Overload**

The ELECTRA/SELECTRA provides protection against excess current being taken from the High Voltage circuit.

The overload current is set in the setup procedure, and is in addition to any standing current taken by the probe. If the HV current exceeds the preset value, the alarm is activated.

**NOTE:** The default level set for Electra is 3.00  $\mu$ A. The user is advised that this level may need to be set uniquely for individual probes to preserve full linear dynamic range whilst retaining the ability to detect light-leaks in scintillation probes. The service manual describes how to calibrate this setting.

The 'S66' setting for parameter F is for probes with dynode impedance nominally 69 M $\Omega$ . 'S120' should be used for probes with dynode impedance nominally 120 M $\Omega$ .

## **Deadtime Limit**

If the countrate reaches the point where the correction would give a true rate equal to five times the measured rate, i.e. the detector is 80% dead, the overload is activated.

This condition will not normally be reached if the overload current has been set correctly.

## **High Rate Limit**

The maximum count rate measurable is 65,535 cps and any rate above this will activate the alarm.

**NOTE:** *The true corrected count rate can exceed 65, 535 cps.*

### *4.2.1.10 Dose Integration*

If a Geiger probe is in use with parameter F set to Geiger and units set to Sv/h, Gy/h or R/h, the second channel will display an integrated dose. This will be reset on switch-on and will continue for the operation of the on/off cycle. The dose acquired can be viewed by pressing the  $\alpha/\beta$  button to toggle between the two states during Rate, Sampler and integrated modes, (N.B. IT IS NOT UPDATED WHILST IN PARAMETER MODE OR RATE-INHIBITED).

## **4.2.2 Parameter Set-Up Mode**

This mode contains all of the operating parameters for the ELECTRA/SELECTRA, and is entered by pressing the **SET UP** key whilst the unit is in a rate monitoring mode.

### *4.2.2.1 Types of parameter*

Some parameters are protected against unauthorised change by a parameter security switch S1-2, situated on the digital board hidden below the end cover at the handle end of the unit. This switch should only be activated by a SUPERVISOR and has two positions, SUPERVISOR and USER. If a particular parameter is valid for the desired mode of operation it may always be viewed, but depending on the state of the parameter set by the SUPERVISOR in SUPERVISOR mode, (i.e. if it is inhibited or not), the operator (USER) may or may not be allowed to alter (or even view, see Section 4.3) the parameter value when the switch is set to USER. Each parameter is classified as follows:

<b>view</b>	This is a view only parameter and may not be altered by the supervisor or the user.
<b>supervisor</b>	The parameter may be viewed and altered only by the supervisor. This parameter is always inhibited to the user as indicated by display of the inhibit symbol.
<b>user</b>	The parameter may be viewed by the supervisor and the user (if allowed, see section 4.3). The supervisor may always change the value of these parameters and by pressing the INHIBIT key may inhibit changes from the user. The user may then only change the value of the parameter if allowed to do so by the supervisor. The inhibit symbol on the LCD will appear when the parameter selected is inhibited to the user.

4.2.2.2 Summary of parameter functions

No.	Parameter	Digital Display	Unit	Class
0	Battery voltage	battery volts	V	view
1	Alarm level ( $\alpha$ , $\beta$ , $\alpha+\beta$ )	alarm countrate, contamination or doserate or OFF	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h	user
2	Stored background ( $\alpha$ , $\beta$ , $\alpha+\beta$ )	background countrate or doserate	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h	view
3	High voltage setting	HV setting	V	user
4	Overload current	overload current	$\mu$ A	user
5	Deadtime	deadtime	$\mu$ s	user
6	Upper Level Discriminator	threshold voltage	V	user
7	Integrate Time	integrate time	s or m	user
8	Units	Unit	cps or cpm or Bq or dpm or Bq/cm <sup>2</sup> or Sv/h or R/h or Gy/h	super
9	Response factor	See section 3.2.3.2		super
A	Inhibit background subtraction	on or oFF		super
b	Inhibit integrate facility	on or oFF		super
C	Rate monitoring algorithm	PrES or Auto		super
d	Preset response time	response time	s	super
E	Pulse counting mode	int or diff or dUAL		super
F	GM or Scintillation (66 M $\Omega$ chain or 120 M $\Omega$ chain)	G or S66 or S120		super
n	Auto switch-off	Off, 1-30	min	user
SELECTRA Only:				
G	Probe Type Number			super
H	Probe Serial Number			super

**NOTE:** For Parameters 8 - H the inhibit symbol is always shown. These parameters are supervisor only and cannot be altered by the user.

#### 4.2.2.3 Detailed description of each parameter

**NOTE:** Full access to each parameter can only be obtained with the security switch, SI-2, set to ON (SUPERVISOR).

**0 - Battery voltage.** The battery voltage is monitored every second with a simulated load and the result is displayed on the LCD. View only.

**1 - Alarm level.** Allows the alarm level to be changed or switched OFF. When **dUAL** probe is selected in Parameter E, pressing the  **$\alpha$ ,  $\beta$ ,  $\alpha+\beta$**  key will toggle between two distinct Alpha and Beta alarm levels, which will be in the units selected in Parameter 8. The alarm may be deactivated by decreasing the level below the minimum allowed, in which case **OFF** is displayed on the 4 digit digital display. Note; Pre-set levels will not be altered when a probe is charged.

**2 - Stored background.** If background subtraction is not inhibited (in Parameter A) this view only parameter displays the current stored background (in the units selected in Parameter 8). If the instrument is in **dUAL** probe operation (set in Parameter E), pressing the  **$\alpha$ ,  $\beta$ ,  $\alpha+\beta$**  key will display the separate Alpha and Beta background levels. If background subtraction is disabled in Parameter A then Parameter 2 will not appear either to the USER or the SUPERVISOR.

**3 - High voltage setting.** This parameter is used to set up the required HV for the probe.

**NOTE:** If the HV is changed when in the SET UP mode, on exiting by pressing the SET UP key, the unit will reset the voltage and then take a few seconds to achieve the voltage value. If the HV is not changed, on exiting the SET UP mode, the unit will revert to normal monitoring mode (RATE) in 1 second.

**4 - Overload current.** The overload current required for the probe can be set and is displayed in  $\mu\text{A}$ . (See section 4.2.1.9).

**5 - Deadtime.** The deadtime in  $\mu\text{s}$  which the unit will use to calculate the true rate from the measured rate can be set. The deadtime chosen should be the combined total of the unit dead time and the probe deadtime.

**6 - Upper Level Discriminator.** This parameter allows the upper level discriminator threshold voltage, ULD to be set (see Parameter E). The value is displayed in volts and is factory set to provide optimum  $\alpha/\beta$  discrimination for use with Thermo dual scintillation probes.

**7 - Integrate time.** This is the time over which an integrate measurement will be performed. If integrate monitoring is disabled in Parameter b, then this parameter will not appear to the USER or SUPERVISOR.

**8 - Units.** The desired units for the display, alarm level(s), background storage and response factor are selected by the supervisor in this parameter.

**9 - Response factor.** This is the response factor used with contamination and doserate measurements only. This parameter will only appear if Bq, dpm, Bq/cm<sup>2</sup>, R/h, Sv/h or Gy/h units have been selected in Parameter 8. If Dual probe is selected in Parameter E, individual response factors for  $\alpha$  and  $\beta$  are available, by pressing the  **$\alpha$ ,  $\beta$ ,  $\alpha+\beta$**  key whilst Parameter 9 is displayed.

**NOTE:** Both  $\alpha$  and  $\beta$  response values **MUST** be entered before SET UP is exited or the unit will show Err C. Refer to Section 6.2.

**A - Inhibit background subtraction.** Background subtraction may be inhibited by the SUPERVISOR (S1-2 ON) by selecting **on** whilst the unit is in the SET UP mode. If background subtraction is inhibited then Parameter 2 will not appear to the USER or SUPERVISOR.

**b - Inhibit integrate facility.** Integrate monitoring may be inhibited by the SUPERVISOR (S1-2 ON) by selecting **on** whilst the unit is in the SET UP mode. If integrate monitoring is inhibited then Parameter 7 will not appear to the USER or SUPERVISOR.

**C - Rate monitoring algorithm.** The ELECTRA may be configured by the supervisor to use a rolling average of 1 second results over a maximum of 16 seconds, but discard the rolling average if the latest result is significantly different. This is the "**Auto**" monitoring mode. Alternatively it can be forced to maintain a rolling average over the time selected in Parameter d. This is the "**PrESet**" mode. The desired mode is selected in this parameter.

**d - Preset response time.** If "**PrESet**" mode is selected above, this is the averaging time used. This parameter will not appear to the USER or SUPERVISOR if "**Auto**" mode is selected.

**E - Pulse counting mode.** Depending on the type of probe, the analogue board must be configured by the supervisor to discriminate pulses in different ways.

Integral (**int**) implies that all pulses whose amplitude is greater than the Lower Level Discriminator will be counted with no upper amplitude limit. Differential (**diff**) implies that pulses whose amplitude are greater than the lower level discriminator but smaller than the preset upper level discriminator (ULD) will be counted. If **dUAL** is selected, the pulse discrimination is automatically set to **diff**; beta particles are then counted between the discriminator levels and alpha particles are counted above the upper level discriminator.

If Parameter F is set to '**G**', i.e. the probe is a Geiger, then **int** is the only available option. Otherwise any of **int**, **diff**, **dUAL** may be selected.

**F - GM or Scintillation.** This parameter is used by the supervisor to select the type of probe. If the option '**G**' is selected then the probe is a Geiger, and the ELECTRA will then assume that the probe can be calibrated for doserate measurements in doserate units (although all other units listed in Parameter 8 above can still be selected). If this parameter is set to **S66** or **S120** for scintillation probes with either a 66 M $\Omega$  or 120 M $\Omega$  dynode chain, overload current calculations (parameter 4) will take the dynode impedance into account.

**NOTE:** *If either Parameters 8, E or F is changed, all information stored in Parameters 1 (Alarm Levels), 2 (Stored Background), if selected, and 9 (Response Factor) is reset to default. The default values are OFF for Parameter 1 and --- for Parameters 2 and 9.*

**n - Auto switch-off.** This parameter will cause the unit to switch off automatically after a predetermined time unless set to OFF (default). At the end of the timed period, the unit will beep 3 times and turn-off.

**NOTE:** *Auto switch-off will not occur if the unit is in integration mode or parameter set up mode. The timed period begins after the last key press.*

## SELECTRA ONLY

**G - Probe Type Number.** A range of probe type numbers is available ranging from AP2 to DP30. Note that the prefix I is **NOT** shown on the display. This parameter is factory set.

**H - Probe Serial Number.** The probe serial number is displayed within the range 100 to 9999. This parameter is factory set and cannot be adjusted by the user.

### 4.2.2.4 *Parameter entry*

The preset parameters can be modified as follows:

- a) Press the **SET UP** key to enter the setup parameter mode.
- b) Use the ▲ and ▼ keys to scroll up and down through the parameters until the desired parameter is displayed. If a parameter has been: inhibited by the supervisor, is a supervisor only parameter or is not valid for a particular configuration, it can only be adjusted when the internal switch, S1-2, is set to SUPERVISOR.
- c) Press the **ENTER** key to select the parameter. If the parameter can be modified (see previous section about parameter modification) the parameter number/letter will flash at approximately 2 Hz. Otherwise the keypress has no effect.
- d) When the parameter number/letter is flashing the operator uses the ▲ and ▼ keys to scroll through the various parameter options.
- e) When the desired value of the parameter is displayed, pressing the **ENTER** key once more will store the value as default.
- f) The operator may now continue to scroll through the parameters, or may press the **SET UP** key once more to exit the set up mode.
- g) If the unit is switched off, or the **SET UP** key is pressed while the parameter number/letter is flashing, the value shown on the display will not be updated and the previous value is used.

### 4.2.2.5 *Parameter inhibit*

Set the internal switch S1-2 to ON (SUPERVISOR).

- a) Press the **SET UP** key to enter the set up parameter mode.
- b) Use the ▲ and ▼ keys to scroll up and down through the parameters until the desired parameter is displayed.
- c) If the parameter is a USER parameter, the supervisor can press the INHIBIT key at this point. The inhibit sign on the LCD will toggle on and off to show whether or not the parameter is to be inhibited to the user. If the parameter is viewable only or is classed as a SUPERVISOR parameter the inhibit symbol will always be displayed and pressing the **INHIBIT** key will have no effect.

## 4.3 INTERNAL SWITCHES S1

The following 4 switches (S1) are situated beneath the end cover at the handle end of the unit:

- S1-1. This switch determines the operation of the unit. For SELECTRA use, this switch must be set to ON. For ELECTRA use this switch must be set to OFF. If **Err d** occurs see section 6.2.
- S1-2. SUPERVISOR/USER mode. With the switch set to SUPERVISOR mode (ON), full access is given within the SET UP parameter routine to change the state or value of any parameter. Once the USER mode (OFF) is selected, only those parameters that were NOT labelled with an inhibit symbol (except view only parameters, 0 and 2) by the SUPERVISOR are allowed to be altered (or viewed, see S1-3 below) by the USER.
- S1-3. HIDE/SHOW mode. This mode only operates with S1-2 set to USER (OFF). If SHOW is selected (OFF), the user parameters that have been inhibited by the SUPERVISOR are visible to the USER (but the user cannot alter their value/state). If HIDE mode (ON) is selected, the user parameters that have been inhibited by the SUPERVISOR are not visible to the USER (the view only parameters are still visible). By using this facility, the unit can be configured by the SUPERVISOR to display only the battery voltage (Parameter 0) to the USER.
- S1-4. TEST mode. If TEST mode is enabled (ON), the unit will enter a test routine that is detailed in Section 6.1. This switch overrides all other switches irrespective of their status except where all switches are on. The switch must be set to disable (OFF) for the instrument to revert to normal use.

**NOTE:** *The unit must be switched OFF and then ON for any change in the switch settings to be registered.*

## 4.4 POTENTIOMETERS

### Volume Adjust

The speaker volume may be adjusted by means of the pot marked with the ramp symbol situated on the digital board protruding through the end plate of the handle end of the unit; clockwise to increase volume. This control will normally be set to maximum volume for the internal speaker, but the volume may need to be adjusted for use with headphones.

### Lower Level Discriminator

The Lower Level Discriminator pot (R21) situated upon the connector end of the HV/amplifier board, type 5460, sets the lower threshold for incoming events. This threshold is factory set and must **NOT** be adjusted. Similarly, R31 must **NOT** be adjusted.

### **IMPORTANT NOTE:**

*R21 and R30 **must not** be adjusted if the electra is to be upgraded to selectra. If there is any doubt that these pots have been adjusted, return the unit to our Service Department for re-calibration.*

## 5. TYPICAL PROBE SET UP PROCEDURE

\* See section 4.2.1.9 for further detail.

This section details the typical set up procedures required for the ELECTRA/SELECTRA-Probe combination. The parameter set up options are detailed in Section 4.2.2.

If the probe has been SET-UP, the correct SET UP parameters are listed on the enclosed certificate. If the probe is an 'I' series probe, the parameters will have been programmed into the probe's on board memory and no further set up will be required. In this instance the section below should be used for routine recalibration or reset of the SET UP parameters after maintenance of the probe (see the relevant probe manual).

### 5.1 DUAL SCINTILLATION PROBES

#### 5.1.1 Probe Set Up

This section covers the setting up procedure for all Thermo Dual Scintillation Probes used for measuring alpha and beta contamination simultaneously. This section should be read in conjunction with the relevant probe manual.

To facilitate the setting up procedure and response, Thermo Radioactive Reference Sources, (RRS Series), as defined in the relevant probe manuals, are recommended.

Before switching the instrument on, remove the end cover from the handle end of the instrument and ensure the internal switch, S1, settings are as follows:

S1-1	ON (SELECTRA)	
	OFF (ELECTRA)	S1-2 ON
S1-3	N/A	S1-4 OFF

**NOTE:** Select S1-1 ON for Thermo 'I' series probes.

- a) Connect the probe by means of a suitable cable (consult the relevant probe manual) and switch ON the ELECTRA/SELECTRA. After initialisation the SET UP key should now be pressed and the function options set. A "0", indicating the parameter number (see section 3.3.1), will appear in the bottom left of the display. By using the  $\blacktriangle$   $\blacktriangledown$  keys the parameters can be scrolled through and viewed. The parameter can be altered by pressing the ENTER key when the required parameter appears on the display. The parameter number/letter will then flash. The  $\blacktriangle$   $\blacktriangledown$  keys can then be used to set the required value/option. On pressing the ENTER key the value is stored as default.



b) The following settings should be used for Thermo Dual Probes:

Number	Parameter	Setting
0	Battery voltage	View only
1	Alarm level ( $\alpha$ and/or $\beta$ )	OFF
3	High voltage setting	Initially 600 V
4	Overload current	3.00 $\mu$ A*
5	Deadtime	3 $\mu$ s
6	Upper Level Discriminator	1.50 V
8	Units	cps or cpm
A	Inhibit background subtraction	ON (Inhibited)
b	Inhibit integrate facility	ON (inhibited)
C	Rate monitoring algorithm	Auto
E	Pulse counting mode	dUAL
F	GM or Scintillation	S66*

**NOTE:** Parameter E should be first set to enable the  $\alpha$ ,  $\beta$  and  $\alpha+\beta$  options to be set upon the alarm levels, if required.

c) Pressing the ENTER key on each parameter sets the options selected into the ELECTRA/SELECTRA memory and also the 'I' probe in the case of the SELECTRA. These values will be used as default on switch on of the ELECTRA.

On switch ON of the SELECTRA, the unit will interrogate the probe's memory and enter the required SET UP parameters into the SELECTRA memory.

d) Press the SET UP key to leave the parameter set up. The unit now reverts to normal RATE monitoring mode.

The Dual Probe operating voltage can then be determined by plotting relevant HV scans with either an  $\alpha$  ( $^{241}\text{Am}$ ) or  $\beta$  ( $^{90}\text{Sr}/^{90}\text{Y}$ ) reference source.

e) Press the  $\alpha$ ,  $\beta$ ,  $\alpha+\beta$  key until the display shows  $\beta$ . Place the probe in the alpha reference source defined in the relevant probe manual. Increase the High Voltage slowly until counts are first observed and then plot a countrate against high voltage curve, in 20 V steps, up to a maximum of 1350 V. The countrate should increase, then decrease, then increase again with increasing High Voltage. Adjust the High Voltage to the centre of the dip in the curve.

Alternatively, press the  $\alpha$ ,  $\beta$ ,  $\alpha+\beta$  key to display  $\alpha$ , and then place the probe in the  $^{90}\text{Sr}/^{90}\text{Y}$  reference source, as defined in the probe manual. Set the HV to 600 V. Observing the countrate in the alpha channel, increase the High Voltage in 20 V steps until counts are first observed. Set the voltage such that approximately 0.1% of the countrate observed in the beta channel is observed in the alpha channel.

The background countrate, measured with the probe removed from the source at the selected high voltage setting should be as specified in the probe manual.

Both methods will set the operating voltage to give the optimum alpha to beta separation for the isotopes used. The High Voltage is specific to the probe, the cable being used, and the discriminator settings of the ELECTRA/SELECTRA. These values along with the probe serial number should be recorded, to avoid unnecessary repetition of the setting up procedure.

#### ***NOTES ON OPTIMUM HV SETTINGS FOR VARIOUS ISOTOPES***

*The optimum alpha to beta separation, determined above, is specific to  $^{90}\text{Sr}/^{90}\text{Y}$  betas and  $^{241}\text{Am}$  alphas only. If operational use is to be performed with beta emitting isotopes of lower energy, the optimum setting will be different. This optimum setting can be obtained by using the beta isotope of interest to determine the 0.1% beta in alpha cut off point. However, it should be pointed out that if measurements are subsequently made with higher energy beta emitting isotopes than the one used for set up, beta breakthrough in the alpha channel will occur.*

*Enhanced performance with alternative beta isotopes can also be obtained by adjusting the Upper Level Discriminator, again taking care that beta breakthrough in the alpha channel and/or loss of alpha performance does not occur.*

- f) The optimum HV setting (and/or ULD setting) determined above should be entered as in the SET UP mode key as defined in section 4.2.2.4. The parameters which are required to be inhibited for the required level of protection from unauthorised tampering should also be set at this stage by pressing the INHIBIT key when the parameter required is viewed in SET UP mode (see section 4.2.2.5). The internal switches should then be set as required (see section 4.3).

## SELECTRA AND 'I' PROBES ONLY

The following parameters only will be written to the probe memory and subsequently read on connection to the SELECTRA.

Number	Parameter	Setting
3	High voltage setting	To be determined
4	Overload current	3.00 $\mu$ A*
5	Deadtime	3 $\mu$ s
6	Upper Level Discriminator	1.50 V
8	Units	As required (cps)
E	Pulse counting mode	dUAL
F	GM or Scintillation	S66*
G	Probe Type Number	Factory set
H	Probe Serial Number	Factory set

The SUPERVISOR may also wish to change the monitoring units. If this is the case the response factor Parameter 9, will appear and, once set, will also be written to the probe memory store.

### ***IMPORTANT NOTE: SELECTRA ONLY***

***Once internal switch SI-2 is set to user (off), any changes entered in the set up parameters will not be written to the probe. The probe will therefore only store the parameters as set up with switch SI-2 set to supervisor (on).***

#### 5.1.2 Probe Response

With the High Voltage set to the optimum alpha and beta separation, as in section 5.1.1 (f) above, measure the source countrate and background countrate. The probe efficiency for the measurement of surface emission of alpha or beta particles is then given by:

$$2\pi \text{ Efficiency} = \frac{\text{Detected Source Countrate} - \text{background countrate}}{\text{Source Emission Rate (particles per second)}} \times 100\%$$

The efficiency for the measurement of activity will be half the efficiency for measurement of surface emission for sources of zero self absorption and zero backscatter.

### 5.1.3 Contamination Measurements

If the probe in use is required to monitor contamination then the relevant unit should be entered in Parameter 8 of the SET UP parameters. Once a unit has been selected, the Response Factor, Parameter 9, MUST be entered.

**NOTE:** *If the contamination unit is changed and the Response Factor is not changed, then on exiting SET UP the unit will show Err C. Refer to section 6.2.*

The response factor required for Bq or dpm is analogous to the probes  $4\pi$  efficiency to the isotope of interest as a fraction of unity. The response factor required for Bq/cm<sup>2</sup> is analogous to the probes  $4\pi$  efficiency to the isotope of interest as a fraction of unity multiplied by the probes sensitive area.

Separate Response Factors are available for **α** and **β** channels with the ranges shown above. The **α** or **β** Factors can be selected by pressing the **α**, **β**, **α+β** key whilst Parameter 9 is displayed. Both **α** and **β** factors MUST be entered before exit from SET UP or the unit will display Err C. Refer to Section 6.2.

#### **EXAMPLE**

DP6 used for contamination measurements of <sup>36</sup>Cl

Probe efficiency to <sup>36</sup>Cl = 38% (2π SER)

∴ 4π probe efficiency to <sup>36</sup>Cl = 19% assuming no backscatter from the source

∴ Response Factor cps/Bq or cpm/dpm = 0.190

Area of probe = 100 cm<sup>2</sup>

∴ Response Factor cps/(Bq/cm<sup>2</sup>) = 0.19 x 100 = 19

## 5.2 ALPHA & BETA SCINTILLATION PROBES

### 5.2.1 Probe Set Up

This section covers the setting up procedure for Thermo scintillation Probes used for alpha and beta contamination measurements. This section should be read in conjunction with the relevant probe manual.

To facilitate the setting up procedure and response, Thermo Radioactive Reference Sources, (RRS Series), as defined in the relevant probe manuals, are recommended.

Before switching the instrument on, remove the end cover from the handle end of the instrument and ensure the internal switch, S1, settings are as follows:

S1-1	ON (SELECTRA)	
	OFF (ELECTRA)	S1-2 ON
S1-3	N/A	S1-4 OFF

**NOTE:** Select S1-1 ON for Thermo 'I' series probes.

- Connect the probe by means of a suitable cable (consult the relevant probe manual) and switch ON the ELECTRA/SELECTRA. After initialisation the SET UP key should now be pressed and the function options set. A "0", indicating the parameter number (see section 3.3.1), will appear in the bottom left of the display. By using the  $\blacktriangle$   $\blacktriangledown$  keys the parameters can be scrolled through and viewed. The parameter can be altered by pressing the ENTER key when the required parameter appears on the display. The parameter number/letter will then flash. The  $\blacktriangle$   $\blacktriangledown$  keys can then be used to set the required value/option. On pressing the ENTER key the value is stored as default.
- The following settings should be used for the Thermo Electron (RMP) Alpha and Beta Probes listed above:

Number	Parameter	Setting
0	Battery voltage	View only
1	Alarm level	OFF
3	High voltage setting	Initially 600 V
4	Overload current	3.00 $\mu$ A*
5	Deadtime	3 $\mu$ s
6	Upper Level Discriminator	1.50 V
8	Units	cps or cpm
A	Inhibit background subtraction	ON (Inhibited)
b	Inhibit integrate facility	ON (inhibited)
C	Rate monitoring algorithm	Auto
E	Pulse counting mode	int
F	GM or Scintillation	S66*

- Pressing the ENTER key on each parameter sets the options selected into the ELECTRA/SELECTRA memory and also the 'I' probe in the case of the SELECTRA. These values will be used as default on switch ON of the ELECTRA.

On switch ON of the SELECTRA, the unit will interrogate the probes memory and enter the required SET UP parameters into the SELECTRA memory.

- d) Press the SET UP key to leave the parameter set up. The unit now reverts to normal RATE monitoring mode.
- e) Place the probe in the reference source as defined in the relevant probe manual. Increase the High Voltage slowly from 600 V in 20 V steps until counts are first observed. Then, either by observation or by plotting a countrate against high voltage curve, determine the voltage at which the rate of change of countrate with voltage is a minimum, i.e. a plateau region. The centre of this 'plateau' is the operating voltage of the probe. This voltage is specific to the discriminator setting of the ELECTRA, the probe and the cable being used. These values along with the probe serial number should be recorded to avoid unnecessary repetition of the setting-up procedure. The background countrate, measured with the probe removed from the source, should be as specified in the probe manual.

If the background is slightly higher, the high voltage may be reduced providing that the operating point remains on the plateau region.

- f) The HV setting determined above should be entered with the SET UP key as defined in section 4.2.2.4. The parameters which are required to be inhibited for the required level of protection from unauthorised tampering should also be set at this stage by pressing the INHIBIT key when the parameter required is viewed in SET UP mode (see section 4.2.2.5). The internal switches should then be set as required (See Section 4.3).

### **SELECTRA AND 'I' PROBES ONLY**

The following parameters only will be written to the probe memory and subsequently read on connection to the SELECTRA.

<b>Number</b>	<b>Parameter</b>	<b>Setting</b>
3	High voltage setting	To be determined
4	Overload current	3.00 $\mu$ A*
5	Deadtime	3 $\mu$ s
6	Upper Level Discriminator	1.50 V
8	Units	As required (cps)
E	Pulse counting mode	int
F	GM or Scintillation	S66*
G	Probe Type Number	Factory set
H	Probe Serial Number	Factory set

The SUPERVISOR may also wish to change the monitoring units. If this is the case the response factor, Parameter 9, will appear and, once set, will also be written to the probe memory store.

### **IMPORTANT NOTE: SELECTRA ONLY**

*Once internal switch S1-2 is set to user (off), any changes entered in the SET UP parameters will **NOT** be written to the probe. The probe will therefore only store the parameters as set up with switch s1-2 set to supervisor (ON).*

## 5.2.2 Probe Response

With the High Voltage set to the optimum value determined in section 5.2.1 (f) above, measure the source countrate and background countrate. The probe efficiency for the measurement of surface emission of alpha or beta particles is then given by:

$$2\pi \text{ Efficiency} = \frac{\text{Detected Source Countrate} - \text{background countrate}}{\text{Source Emission Rate (particles per second)}} \times 100\%$$

The efficiency for the measurement of activity will be half the efficiency for measurement of surface emission for sources of zero self absorption and zero backscatter.

## 5.2.3 Contamination Measurements

If the probe in use is required to monitor contamination, then the relevant unit should be entered in Parameter 8 of the SET UP parameters. Once a unit has been selected, the Response Factor, Parameter 9, MUST be entered.

**NOTE:** *If the contamination unit is changed and the Response Factor is not changed then on exiting SET UP the unit will show Err C. Refer to section 6.2.*

The response factor required for Bq or dpm is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity. The response factor required for Bq/cm<sup>2</sup> is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity multiplied by the probe's sensitive area.

### **EXAMPLE**

BP7 used for contamination measurements of <sup>14</sup>C

Probe efficiency to <sup>14</sup>C = 18% ( $2\pi$  SER)

$\therefore$   $4\pi$  probe efficiency to <sup>14</sup>C = 9% assuming no backscatter from the source

$\therefore$  Response Factor cps/Bq or cpm/dpm = 0.090

Area of probe = 49 cm<sup>2</sup>

$\therefore$  Response Factor cps/ (Bq/cm<sup>2</sup>) = 0.09 x 49 = 4.41

## 5.3 GAMMA SCINTILLATION PROBES

### 5.3.1 Probe Set Up

Gamma Probes can be set up for integral or differential operation as defined in 4.2.2.3 (Parameter E).

For integral operation the set up procedure is the same as that described in Section 5.2 for alpha or beta probes, i.e. to set the voltage at the centre of the “plateau” region.

The differential mode of operation can be used in some applications to reduce the background countrate and thereby enhance the probes minimum detectable activity.

To facilitate the setting up procedure and response, a radioactive source of the nuclide which is to be measured is required. For the GP13 probe Thermo Radioactive Reference Source RRS59A ( $^{129}\text{I}$ ,  $^{125}\text{I}$  equivalent) is recommended. For the GP22 and GP23, a small  $^{137}\text{Cs}$  source of approximate activity 37 kBq (1  $\mu\text{Ci}$ ) placed at 2.5 cm from the sensitive end of the probe is recommended.

The procedure for setting up the probes listed above in the differential mode is as follows.

Before switching the instrument on, remove the end cover from the handle end of the instrument and ensure the internal switch, S1, settings are as follows:

S1-1	ON (SELECTRA)	
	OFF (ELECTRA)	S1-2 ON
S1-3	N/A	S1-4 OFF

**NOTE:** Select S1-1 to ON for Thermo ‘I’ series probes.

- Connect the probe by means of a suitable cable (consult the relevant probe manual) and switch ON the ELECTRA/SELECTRA. After initialisation, the SET UP key should now be pressed and the function options set. A “0”, indicating the parameter number (see section 3.3.1), will appear in the bottom left of the display. By using the  $\blacktriangle$   $\blacktriangledown$  keys the parameters can be scrolled through and viewed. The parameter can be altered by pressing the ENTER key when the required parameter appears on the display. The parameter number/letter will then flash. The  $\blacktriangle$   $\blacktriangledown$  keys can then be used to set the required value/option. On pressing the ENTER key the value is stored as default.



b) The following settings should be used for Gamma Probes:

Number	Parameter	Setting
0	Battery voltage	View only
1	Alarm level	OFF
3	High voltage setting	Initially 600 V
4	Overload current	3.00 $\mu$ A*
5	Deadtime	4 $\mu$ s
6	Upper Level Discriminator	2.40 V
8	Units	cps or cpm
A	Inhibit background subtraction	ON (Inhibited)
b	Inhibit integrate facility	ON (inhibited)
C	Rate monitoring algorithm	Auto
E	Pulse counting mode	diff
F	GM or Scintillation	S66* for 'GP'xx 'IGP'xx probes S120* for 'G'x probes

c) Pressing the ENTER key on each parameter sets the options selected into the ELECTRA memory and also the 'I' probe in the case of the SELECTRA. These values will be used as default on switch ON of the ELECTRA.

On switch ON of the SELECTRA, the unit will interrogate the probe's memory and enter the required SET UP parameters into the SELECTRA memory.

d) Press the SET UP key to leave the parameter set up. The unit now reverts to normal RATE monitoring mode.

e) Using the source defined above, increase the High Voltage in 20 V steps until counts are first observed. Then carefully increase the High Voltage until a peak in the measured rate is obtained. Record the High voltage, Upper Level Discriminator (ULD) voltage, countrate with the source and the background rate at this voltage.

f) Repeat the procedure of (e) for different values of the ULD down to the minimum (150 mV), with the source in an identical position. From these results select the optimum setting to give maximum sensitivity either by observation or by calculating  $S^2/B$  for each setting and choosing that setting giving the maximum value of  $S^2/B$  where:

$S = (\text{measured rate with source} - \text{background rate})$  and,

$B = \text{background rate}.$

The HV and ULD voltages are the settings for the nuclide used and are specific to the discriminator setting of the ELECTRA/SELECTRA, the probe and the cable used. These details should be recorded along with the probe serial number to avoid unnecessary repetition of the setting up procedure.

g) The HV and ULD settings, determined above, should be entered with the SET UP key as defined in section 4.2.2.4. The parameters which are required to be inhibited for the required level of protection from unauthorised tampering should also be set at this stage by pressing the INHIBIT key when the parameter required is viewed in SET UP mode (see section 4.2.2.5). The internal switches should then be set as required (see section 4.3).

## SELECTRA AND 'I' PROBES ONLY

The following parameters only will be written to the probe memory and subsequently read on connection to the SELECTRA.

Number	Parameter	Setting
3	High voltage setting	To be determined
4	Overload current	3.00 $\mu\text{A}^*$
5	Deadtime	4 $\mu\text{s}$
6	Upper Level Discriminator	1.50 V
8	Units	As required (cps)
E	Pulse counting mode	int or diff
F	GM or Scintillation	See previous note
G	Probe Type Number	Factory set
H	Probe Serial Number	Factory set

The SUPERVISOR may also wish to change the monitoring units. If this is the case the response factor, Parameter 9, will appear and, once set, will also be written to the probe memory store.

### **IMPORTANT NOTE: SELECTRA ONLY**

*Once internal switch S1-2 is set to USER (OFF), any changes entered in the SET UP parameters will **NOT** be written to the probe. The probe will therefore only store the parameters as set up with switch S1-2 set to SUPERVISOR (ON).*

### 5.3.2 Contamination Measurements

If the probe in use is required to monitor contamination, then the relevant unit should be entered in Parameter 8 of the SET UP parameters. Once a unit has been selected, the Response Factor, Parameter 9, MUST be entered.

**NOTE:** *If the contamination unit is changed and the Response Factor is not changed then on exiting SET UP the unit will show Err C. Refer to section 6.2.*

The response factor required for Bq or dpm is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity. The response factor required for Bq/cm<sup>2</sup> is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity multiplied by the probe's sensitive area.

### **EXAMPLE**

GP13 used for contamination measurements of <sup>129</sup>I

Probe efficiency to <sup>129</sup>I = 55% ( $2\pi$  SER)

$\therefore$   $4\pi$  probe efficiency to <sup>129</sup>I = 27.5% assuming no backscatter from the source

$\therefore$  Response Factor cps/Bq or cpm/dpm = 0.275

Area of probe = 100 cm<sup>2</sup>

$\therefore$  Response Factor cps/ (Bq/cm<sup>2</sup>) = 0.275 x 100 = 27.5

## 5.4 GEIGER COUNTRATE PROBE

### 5.4.1 Probe Set Up

This section deals with the setup procedure for all types of Thermo Geiger probes displaying in countrate.

Before switching the instrument on, remove the end cover from the handle end of the instrument and ensure the internal switch, S1, settings are as follows:

S1-1	ON (SELECTRA)	
	OFF (ELECTRA)	S1-2 ON
S1-3	N/A	S1-4 OFF

**NOTE:** Select S1-1 to ON for Thermo 'T' series probes.

- Connect the probe by means of a suitable cable (consult the relevant probe manual) and switch ON the ELECTRA/SELECTRA. After initialisation, the SET UP key should now be pressed and the function options set. A "0", indicating the parameter number (see section 3.3.1), will appear in the bottom left of the display. By using the  $\blacktriangle$   $\blacktriangledown$  keys the parameters can be scrolled through and viewed. The parameter can be altered by pressing the ENTER key when the required parameter appears on the display. The parameter number/letter will then flash. The  $\blacktriangle$   $\blacktriangledown$  keys can then be used to set the required value/option. On pressing the ENTER key the value is stored as default.
- The following settings should be used for the Thermo Electron (RMP) Probes listed above:

Number	Parameter	Setting
0	Battery voltage	View only
1	Alarm level	OFF
3	High voltage setting	See Table 5.1
4	Overload current	See Table 5.1
5	Deadtime	See Table 5.1
6	Upper Level Discriminator	1.50 V
8	units	cps or cpm
A	Inhibit background subtraction	ON (Inhibited)
b	Inhibit integrate facility	ON (inhibited)
C	Rate monitoring algorithm	Auto
E	Pulse counting mode	int
F	GM or Scintillation	G

Geiger Probe Type	Deadtime	Overload Current	HV Setting
BP1/4B	120 $\mu$ s	20 $\mu$ A	450 V
BP3/4	30 $\mu$ s	10 $\mu$ A	370 V
BP14C	70 $\mu$ s	40 $\mu$ A	900 V
PGM	50 $\mu$ s	40 $\mu$ A	900 V

**TABLE 5.1 - GEIGER PROBE SETUP PARAMETERS**

- c) Pressing the ENTER key on each parameter sets the options selected into the ELECTRA/SELECTRA memory and also the 'I' probe in the case of the SELECTRA. These values will be used as default on switch ON of the ELECTRA.

On switch ON of the SELECTRA, the unit will interrogate the probe's memory and enter the required SET UP parameters into the SELECTRA memory.

- d) Press the SET UP key to leave the parameter set up. The unit now reverts to normal RATE monitoring mode.

The High Voltage setting can be checked by plotting a countrate against HV curve with a suitable radioactive source (see the relevant probe manual). The HV should be set to the centre of the plateau region.

- e) The parameters which are required to be inhibited for the required level of protection from unauthorised tampering should be set by pressing the INHIBIT key when the parameter is viewed in SET UP mode (see section 4.2.2.5). The internal switches should then be set as required (see section 4.3).

### **SELECTRA AND 'I' PROBES ONLY**

The following parameters only will be written to the probe memory and subsequently read on connection to the SELECTRA.

<b>Number</b>	<b>Parameter</b>	<b>Setting</b>
3	High voltage setting	See Table 5.1
4	Overload current	See Table 5.1
5	Deadtime	See Table 5.1
6	Upper Level Discriminator	1.50 V
8	Units	As required (cps)
E	Pulse counting mode	int
F	GM or Scintillation	G
G	Probe Type Number	Factory set
H	Probe Serial Number	Factory set

The SUPERVISOR may also wish to change the monitoring units. If this is the case the response factor, Parameter 9, will appear and, once set, will also be written to the probe memory store.

### ***IMPORTANT NOTE: SELECTRA ONLY***

*Once internal switch S1-2 is set to USER (OFF), any changes entered in the SET UP parameters will **NOT** be written to the probe. The probe will therefore only store the parameters as set up with switch S1-2 set to SUPERVISOR (ON).*

## 5.4.2 Contamination Measurements

If the probe in use is required to monitor contamination, then the relevant unit should be entered in Parameter 8 of the SET UP parameters. Once a unit has been selected, the Response Factor, Parameter 9, MUST be entered.

**NOTE:** *If the contamination unit is changed and the Response Factor is not changed then on exiting SET UP the unit will show Err C. Refer to section 6.2.*

The response factor required for Bq or dpm is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity. The response factor required for Bq/cm<sup>2</sup> is analogous to the probe's  $4\pi$  efficiency to the isotope of interest as a fraction of unity multiplied by the probe's sensitive area.

### **EXAMPLE**

BP14 used for contamination measurements of <sup>241</sup>Am ( $\alpha$ )

Probe efficiency to <sup>241</sup>Am = 32% ( $2\pi$  SER)

$\therefore$   $4\pi$  probe efficiency to <sup>241</sup>Am = 16% assuming no backscatter from the source

$\therefore$  Response Factor cps/Bq or cpm/dpm = 0.160

Area of probe = 20 cm<sup>2</sup>

$\therefore$  Response Factor cps/ (Bq/cm<sup>2</sup>) = 0.160 x 20 = 3.2

## 5.5 DOSERATE PROBE

### 5.5.1 Probe Set Up

This sub-section deals with the set-up procedure for Thermo Electron (RMP) energy compensated Geiger probes.

Before switching the instrument on, remove the end cover from the handle end of the instrument and ensure the internal switch, S1, settings are as follows;

S1-1	ON (SELECTRA)	
	OFF (ELECTRA)	S1-2 ON
S1-3	N/A	S1-4 OFF

**NOTE:** Select S1-1 to ON for Thermo 'T' series probes.

- a) Connect the probe by means of a suitable cable (consult the relevant probe manual) and switch ON the ELECTRA/SELECTRA. After initialisation, the SET UP key should now be pressed and the function options set. A "0", indicating the parameter number (see section 3.3.1), will appear in the bottom left of the display. By using the ▲ ▼ keys the parameters can be scrolled through and viewed. The parameter can be altered by pressing the ENTER key when the required parameter appears on the display. The parameter number/letter will then flash. The ▲ ▼ keys can then be used to set the required value/option. On pressing the ENTER key the value is stored as default.
- b) The following settings should be used for the Thermo Electron (RMP) Probes listed above:

Number	Parameter	Setting
0	Battery voltage	View only
1	Alarm level	OFF
3	High voltage setting	See Geiger Probe Manual
4	Overload current	See Note (3) below
5	Deadtime	See Geiger Probe Manual
6	Upper Level Discriminator	1.50 V
8	Units	As required
9	Response Factor	See Geiger Probe Manual
A	Inhibit background subtraction	ON (inhibited)
b	Inhibit integrate facility	ON (inhibited)
C	Rate monitoring algorithm	Auto
E	Pulse counting mode	int
F	GM or Scintillation	G

**NOTE (1):** The response factors quoted in the relevant probe manual may be default values. These values must be used unless a more accurate calibration has been performed..

**NOTE (2):** If the dose/exposure rate unit is changed without changing the response factor, the unit will display Err C (see section 6.2).

**NOTE (3):** Overload current, parameter 4 should be set to 0.1 x dead time (listed in the Geiger Probe Manual).

- c) Pressing the ENTER key on each parameter sets the options selected into the ELECTRA/SELECTRA memory and also the 'I' probe in the case of the SELECTRA. These values will be used as default on switch ON of the ELECTRA.

On switch ON of the SELECTRA, the unit will interrogate the probe's memory and enter the required SET UP parameters into the SELECTRA memory.

- d) Press the SET UP key to leave the parameter set up. The unit now reverts to normal RATE monitoring mode.

The High Voltage setting can be checked by plotting a countrate against HV curve with a suitable radioactive source (see the relevant probe manual). The HV should be set to the centre of the plateau region.

- e) The parameters which are required to be inhibited for the required level of protection from unauthorised tampering should be set by pressing the INHIBIT key when the parameter is viewed in SET UP mode (see section 4.2.2.5). The internal switches should then be set as required (see section 4.3).

### **SELECTRA AND 'I' PROBES ONLY**

The following parameters only will be written to the probe memory and subsequently read on connection to the SELECTRA.

<b>Number</b>	<b>Parameter</b>	<b>Setting</b>
3	High voltage setting	See Geiger Probe Manual
4	Overload current	See Note (3)
5	Deadtime	See Geiger Probe Manual
6	Upper Level Discriminator	1.50 V
8	Units	As required (cps)
E	Pulse counting mode	int
F	GM or Scintillation	G
G	Probe Type Number	Factory set
H	Probe Serial Number	Factory set

The SUPERVISOR may also wish to change the monitoring units. If this is the case the response factor, Parameter 9, will appear and, once set, will also be written to the probe memory store.

### ***IMPORTANT NOTE: SELECTRA ONLY***

*Once internal switch S1-2 is set to USER (OFF), any changes entered in the SET UP parameters will **NOT** be written to the probe. The probe will therefore only store the parameters as set up with switch S1-2 set to SUPERVISOR (ON).*

## 6. SELF TEST ROUTINES AND ERROR MESSAGES

### 6.1 SELF TEST ROUTINES

The instrument incorporates its own test functions to enable the customer to check the integrity of the unit. The TEST mode is selected by setting the internal option switch, S1-4, situated underneath the plastic protective end cover at the handle end of the unit, to ON and then switching the unit OFF then ON. Switch S1-4 overrides the status of all other switches S1-1, S1-2 and S1-3.

On changing S1-4 to ON, and subsequently switching the unit ON, the display will show tEst1. The  $\blacktriangle$  and  $\blacktriangledown$  keys can then be used to scroll through the tests available. Each test can be selected on pressing the **ENTER** key when the display shows the test number required.

#### tEst1

On pressing **ENTER** the issue number of the software will be displayed. The display will remain unaltered until the **SET UP** or **ENTER** key is pressed.

#### tEst2 - Keypad Test

On pressing **ENTER**, the program displays the name of the key that should be subsequently pressed i.e. **rAtE = RATE INTEG** key and so on. If the correct key is pressed, a short tone is audible and the next key that should be pressed is shown on the display. If the incorrect key is pressed, the inhibit symbol is displayed for a short time and no tone is emitted. The last key to be tested is the up ( $\blacktriangle$ ) key which exits the test.

#### tEst3 - Display Test

Press **ENTER** to enter tEst3. This test consists of subtests designed to test every segment upon the display. The SET UP key ends the complete test and the ENTER key changes the display sub test. The subtests are as follows:

On pressing ENTER all segments are lit. Further presses of the ENTER key will yield:

- 1 Test bargraph segments and scales
- 2 Test numeric segments
- 3 Test unit prefixes and remaining indication symbols (sounder, low battery warning, inhibit symbol, ' $\alpha + \beta$ ' symbols)
- 4 Test units

#### tEst4 - Option Switches

Press **ENTER** to enter tEst4. The display shows a 1 if the switch is ON and a 0 if the switch is OFF. Changing the status of the switch will change the display for the relevant switch.



The **SET UP** and **ENTER** key will cancel the test.

**tEst5 - DAC1 test**

**tEst6 - DAC2 test**

**tEst7 - DAC3 test**

These tests are used to check each of the Digital to Analogue converters (DAC's) on the HV/Amplifier board. Firstly, the DAC is made to ramp up and down at about 100 Hz. When the **ENTER** key is pressed, the DAC is then set to an upper limit and the expected voltage at the test socket is displayed. Further presses of the **ENTER** key will step (decrement) this voltage. The test can be cancelled by pressing the **SET UP** key (or by pressing the **ENTER** key when 0.00 is displayed). The test voltage steps are as follows:

DAC1 and DAC3	1.50	1.20	0.90	0.60	0.30	0.00
DAC2	3.00	2.40	1.80	1.20	0.60	0.00

**tEst8 - Calibrate HV**

Press **ENTER** to enter tEst8. This test switches on the HV generation circuitry and, as **ENTER** is pressed, the voltage is stepped from 0 V to 1400 V in 200 V steps in order to test the HV linearity. The expected output voltage is displayed. The voltage should be monitored at the probe socket with an accurate DVM and 1000:1 potential divider. The test may be cancelled at any time by pressing the **SET UP** or by pressing the **ENTER** key when the display shows 1400 V.

**WARNING:** *THE HV SHOWN ON THE DISPLAY IS PRESENT AT THE PROBE CONNECTOR.*

**tEst9 - HV Error Check**

Press **ENTER** to enter tEst9. This test checks the HV error circuitry. The HV output is switched from 900 V to 800 V and the inhibit symbol is displayed. Once 800 V is reached the inhibit symbol will disappear and the HV is switched from 800 V to 900 V and again the inhibit symbol will be displayed. Once 900 V is reached, the inhibit symbol disappears and the HV is switched from 900 V to 800 V and the process starts again. Therefore, if the analogue board is working correctly, the inhibit symbol will appear to flash at about 1 Hz. The test can be exited by pressing the **SET UP** or **ENTER** key and waiting until a cycle is complete.

**WARNING:** *THE HV SHOWN ON THE DISPLAY IS PRESENT AT THE PROBE CONNECTOR.*

The Test mode is terminated by switching the unit OFF and then ON with the switch S1-4 set to OFF.

## 6.2 ERROR MESSAGES

The instrument incorporates its own error parameters which will prevent the instrument from being used if the processor suspects that the unit is not functioning correctly. The following error messages may be displayed:

Err 0	Eprom Checksum Error
Err 1	Ram Checksum Error
Err 2	Ram Fault
Err 3	E <sup>2</sup> prom Checksum Error
Err 4	E <sup>2</sup> prom Read Error
Err 5	E <sup>2</sup> prom Write Error
Err 6	HV Fault
Err 7	Code Error

These error messages are fatal, which implies that the unit will become inoperable once a message is displayed, except for Err 1 which implies that the set up parameters have been corrupted. These parameters can be recovered by entering supervisor mode (S1-2 ON) and re-entering the relevant parameters required.

If fatal errors are observed and the unit becomes inoperable, please contact the Service Department for further information.

### Err A

This error message is non-fatal and occurs whenever S66 or S120 is selected for parameter F and the Overload current (parameter 4) is set  $> 20 \mu\text{A}$ . If this error appears, press **SET UP** and reduce the overload current for the scintillation probe. On exiting SET UP mode, the error message will no longer be displayed and the unit will enter normal RATE monitoring mode.

***NOTE:** The instrument is specified for a maximum of 10  $\mu\text{A}$  overload current when a 66 M $\Omega$  probe is used at 1400 V.*

### Err C

This error message is non-fatal and occurs when no response factor has been entered when units of Bq, dpm, Bq/cm<sup>2</sup>, Sv/h, R/h or Gy/h are selected. If this error appears, press **SET UP** and enter the required response factor (parameter 9) relevant to the probe being used or set the UNITS (parameter 8) to cps or cpm. On exiting SET UP mode, the error message will no longer be displayed and the unit will enter normal RATE monitoring mode.

***NOTE:** If a Dual Scintillation Probe is connected both  $\alpha$  AND  $\beta$  response factors **MUST** be entered or Err C will appear.*

## **Err d**

### **ELECTRA OPERATION**

This error message is fatal and will appear if switch S1-1 is set to ON and the unit is switched ON. If this error message appears, switch the unit OFF, set switch S1-1 to OFF and switch the unit ON. After a few seconds the unit will revert to normal rate monitoring mode. Switch S1-1 must always be set to OFF for ELECTRA use.

### **SELECTRA OPERATION**

This error message will appear if S1-1 is set to ON for SELECTRA but no probe is connected. It will also appear if the probe is disconnected whilst the unit is ON. Under these conditions it could be possible to corrupt the data stored in the probe. If a USER observes Err d, he/she should inform their immediate SUPERVISOR who can check the stored probe parameters against original response settings. In this case Err d is **non-fatal** and operation can be regained simply by connecting a probe and switching the unit ON.

## **7. MAINTENANCE**

Periodically typically every 12 months, the ELECTRA/SELECTRA should be checked for performance. There are two key areas:-

- a) The ELECTRA/SELECTRA is accurately calibrated to ensure that probes can be used on any unit with the same settings.
- b) Protection against electro-magnetic interference relies on metal screen-plates.

Please refer to the service manual for appropriate action to be taken or contact the Service Department.

### **7.1 CLEANING INSTRUCTIONS**

***WARNING: SWITCH OFF THE INSTRUMENT BEFORE CLEANING.***

Use a standard spray polish suitable for painted, metal surfaces. Do not spray cleaner directly onto labels, instead apply spray to soft lint free cloth and wipe clean. Do not attempt to wipe clean probe active surfaces.

## 8. UPGRADES

Please contact our Service Department at the address below for details of conversions from:

- i) Electra 1A or B to Selectra 1A for use with intelligent probes.
- ii) Electra 1A/B to Electra Plus 1A/B  
or  
Selectra 1A to Selectra Plus 1A for data-logging and enhanced functions.
- iii) Electra 1A/B to Electra GM 1A/B  
or  
Selectra 1A to Selectra GM 1A for additional internal energy compensated Geiger.

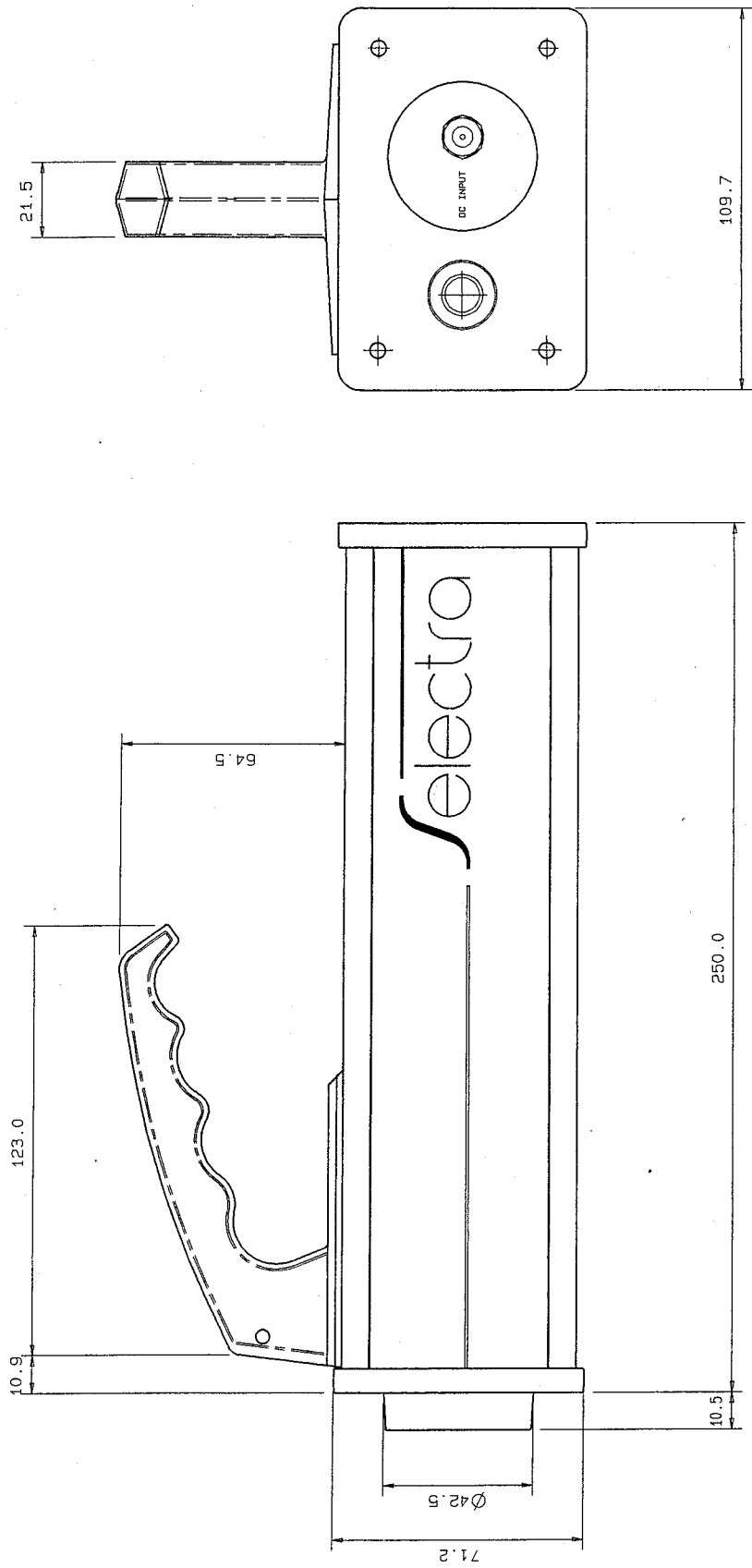
The 'Plus' and 'GM' kits can be combined to provide (S)Electra GM Plus 1A/B.

Service Department  
Thermo Electron Corporation (Radiation Measurement & Protection)  
Bath Road  
Beenham  
Reading, RG7 5PR  
Berkshire  
ENGLAND

Telephone:	0118 9712121	National
	+44 118 9712121	International
Fax:	+44 118 9712835	

C38719

THIRD ANGLE PROJECTION

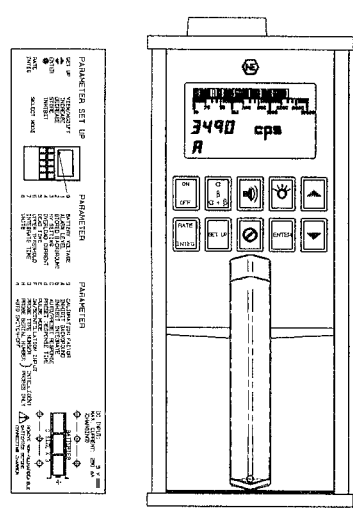


APPROX WEIGHT : - 1.22 KILOGRAMMES EXCLUDING BATTERIES

ISO THREADS CLASS 6g/6H

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SPEC.	_____	1 DEC.PL. ± 0.4 2 DEC.PL. ± 0.15	E. A. MORRISON	1	23.10.91	001.6577														
FINISH.	REMOVE ALL BURRS.	DIMENSIONS IN MM	CHKD.																	
	_____	SCALE 1 : 1	APPD.																	
	_____	<input checked="" type="checkbox"/> UNLESS STATED																		
			TITLE		OUTLINE DRAWING		Therma LABORATORIES		Bath Road, Bamberham, Reading, Berkshire RG7 5PR ENGLAND		DRG. NO.		C38719							
			PORTABLE MONITOR ELECTRA & SELECTRA																	

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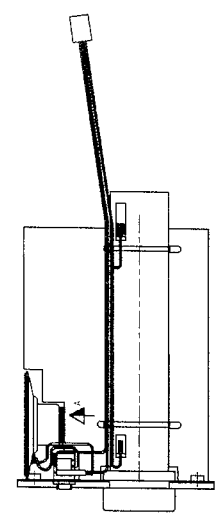
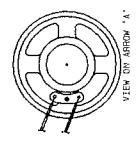
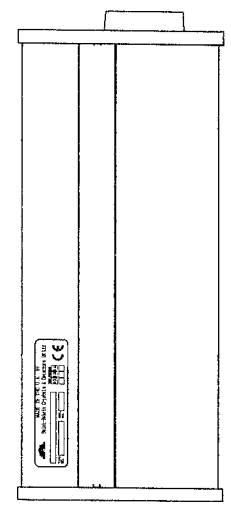
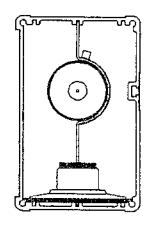
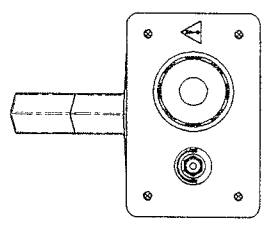
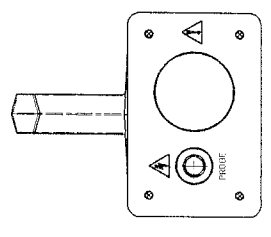
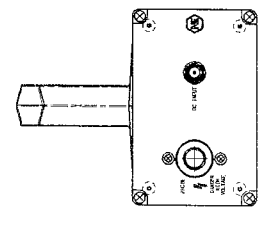
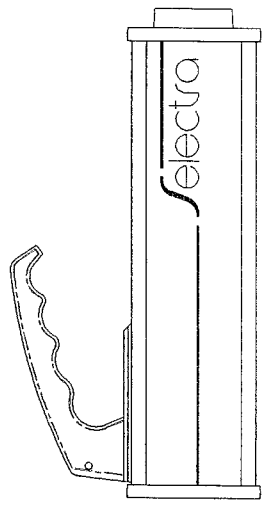
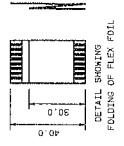
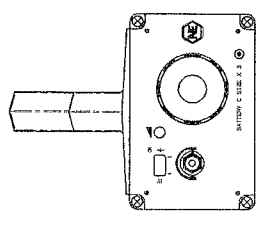
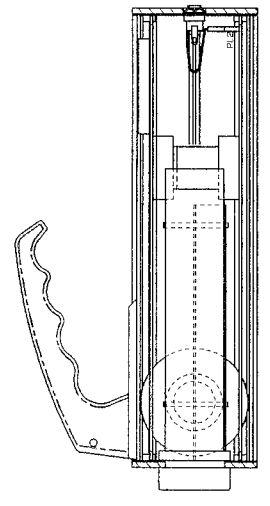
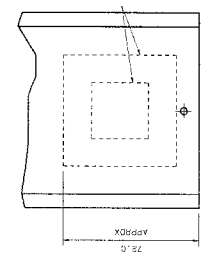


**THREE ANGLE PROJECTION**

PARAMETERS SET UP

PARAMETERS

**PARAMETERS**



PROJ.	SEE BOM E36715/A, B & C	DESIGNED BY	TELEVISION WORKS LTD	DATE	20/1/80
SCALE	SEE BOM E36715/A, B & C	DRAWN BY	T.M. / J.P.	DATE	17/05/77
WORKS	PORT AL BOURN	CHECKED BY	M.P.	DATE	27/10/80
		APPROVED BY	J.P.	DATE	02/08/81
		MANUFACTURED BY	Thermo		
		LOCATION	Electronics Division		
			Bath Road, Broomfield, Reading, RG6 2BE, U.K.		
		TITLE	PORTABLE MONITOR		
		DRAWN	J.P.		
		SCALE	1:1		
		DATE	21/1/80		
		ISSUED BY	J.P.		
		ISSUED TO	TELEVISION WORKS LTD		
		ISSUED FOR	ELECTRA1A & B & SELECTRA1A		

ISO TOLERANCE CLASS BS 68

MANUFACTURE TO DIMENSIONS SHOWN. FURNISHING TOLERANCE ALLOWED UNLESS SPECIFIED.