

BOECO MODEL S-22
UV/VISIBLE RANGE
SPECTROPHOTOMETER
OPERATING MANUAL

SAFETY

Please read this information carefully prior to installing or using this equipment.

1. The unit described in this manual is designed to be operated only by trained personnel. Any adjustments, maintenance and repair must be carried out as defined in this manual, by a person qualified to be aware of the hazards involved.
2. It is essential that both operating and service personnel employ a safe system of work, in addition to the detailed instructions specified in this manual.
3. The covers on the unit should only be removed by personnel who have been trained to avoid the risk of shock.
4. References should always be made to the Health and Safety data supplied with any chemicals used. Generally accepted laboratory procedures for safe handling of chemicals should be employed.
5. If it is suspected that safety protection has been impaired in any way, the unit must be made inoperative and secured against any intended operation. The fault condition should immediately be reported to the appropriate servicing authority.

S-22 SPECTROPHOTOMETER OPERATING MANUAL

CONTENTS

SECTION 1	INTRODUCTION	
	Instrument Description	1.1
	Instrument Specification	1.2
SECTION 2	INSTALLATION	
	Unpacking	2.1
	Installation	2.2
	Displays	2.3
	Controls	2.4
	Outputs	2.5
SECTION 3	OPERATION	
	Initial Set-Up	3.1
	Sample Measurement	3.2
	Good Practice Guidelines	3.3
SECTION 4	MAINTENANCE	
	General	4.1
	Light Source Replacement	4.2
SECTION 5	OPTIONAL ACCESSORIES	
	Optional Accessories	5.1
	Spares	5.2
SECTION 6	INTERFACING	
	Analogue	6.1
	RS232	6.2

SECTION 1

INTRODUCTION

1.1 INSTRUMENT DESCRIPTION

The Model S-22 is a microprocessor controlled UV/Visible Range Spectrophotometer covering the wavelength range of 198 to 1000nm with an 8nm bandwidth. The monochromator is of a modified Czerny Turner design, incorporating a stepper motor driven 1200 lines/mm holographic diffraction grating and featuring automatic second order response suppression. The S-22 uses a long life compact Xenon Flash Lamp Module light source, which provides a continuous spectrum across the full operating wavelength range. The S-22 has full interfacing capability for Analogue output and serial (RS232) interfacing. The optical system is independantly housed and isolated with lenses to give maximum protection from environmental contamination. Combined with a mechanically rigid structure, the S-22 provides a system with fast warm-up, low drift and high reliability.

1.2 INSTRUMENT SPECIFICATIONS

Wavelength:

Range	198 - 1000nm
Resolution	1nm
Accuracy	±2nm
Bandwidth	8nm

Transmittance:

Range	0 to 199.9%
Resolution	0.1%
Stray Light	<0.5%T at 340 and 220nm
Photometric Accuracy	±1%

Absorbance:

Range	-0.300 to 1.999A
Resolution	0.001A

Concentration:

Range	-300 to 1999 Concentration
Resolution	0.1/1
Units	ppm, mg/l, g/l, M, blank

Factor

0 to 199.9, 1000 to 9999

Photometric Noise Levels:

<1%

Photometric Stability:

1%/Hr after 20 minute warm-up

Readout:

Custom LCD Graphics display

Outputs:

Analogue (0 - 1.999V d.c.) / RS232 serial port

Light Source:

Xenon Flash Lamp Module

Input Voltage:

115/230Vac -20% + 10%

Input Power:

<50W

Size:

365 (w) x 272 (d) x 160 (h)mm

Weight:

6Kgs

SECTION 2

INSTALLATION

2.1 UNPACKING

Remove the Model S-22 from the packaging and ensure the following items are present:

1. Model S-22 Spectrophotometer
2. Mains Cable
3. Pack 100 disposable Cuvettes (BOE 060 084)
4. Optional Accessories (as ordered)

Any shortages or damage should be reported immediately to the Manufacturer or your local Distributor.

2.2 INSTALLATION

MAINS SUPPLY

The S-22 is designed to operate on 115/230V a.c. supplies (-20%+10%) 50/60Hz.

The standard 2 metre mains cable supplied with the unit is fitted with an IEC type connector which can be plugged directly into the POWER IN socket on the rear panel.

The mains fuse is housed within the POWER IN socket. When replacing the fuse the unit should be disconnected from the mains supply.

In the event of the fuse failing after replacement it is advisable to consult with the Manufacturer or your local Distributor before proceeding further.

Fuse Rating: 2A 'F' (fast blow type)

NOTE: The unit should be positioned within 1.5 metres of an earthed mains supply.

VOLTAGE SELECT

NOTE: When changing the voltage select switch position always ensure the fuse rating is correct.

Before attempting to change the voltage select disconnect the instrument from the mains supply. Withdraw the fuse holder from the power input socket and remove the fuse. Extract the grey fuse retainer and rotate so that the correct voltage is visible through the aperture in the fuse holder. Replace the fuse retainer in its holder, fit the correct fuse and push assembly back into the power input socket.

MAINS CONNECTIONS

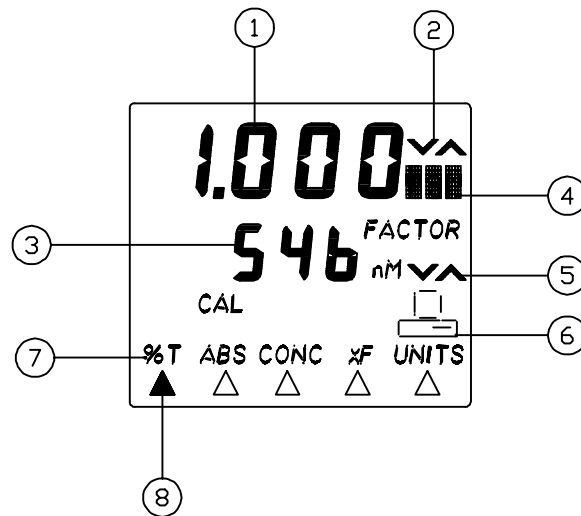
A suitable plug should be connected to the 3 wires on the mains lead. These are colour coded to conform to the internationally recognised standard such that:

BROWN	LIVE
BLUE	NEUTRAL
GREEN/YELLOW	EARTH

IMPORTANT: THE UNIT MUST BE EARTHED.

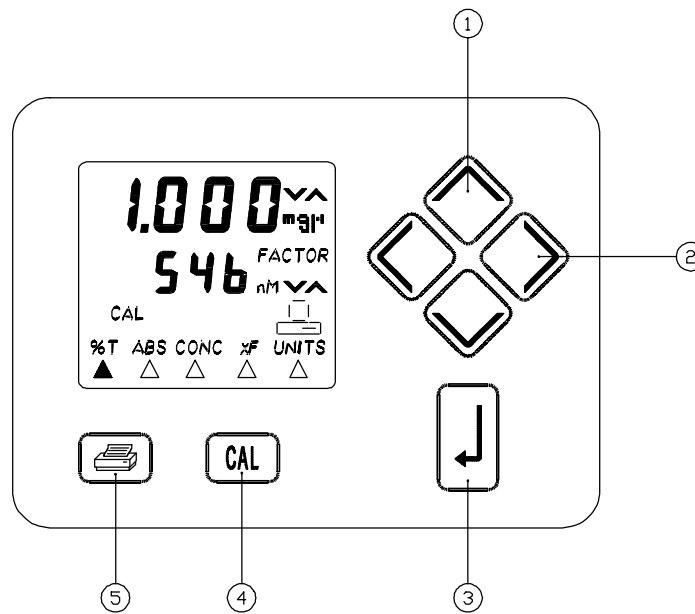
The Green/Yellow wire in the a.c. supply cable must be connected to a properly grounded terminal.

2.3 DISPLAYS



1. Primary display area - Transmission, Absorbance, Concentration
2. Primary display adjust annunciator
3. Secondary display area - Wavelength, Factor
4. Primary display units
5. Secondary display adjust annunciator
6. Operation with PC
7. Menu options - %T ABS CONC FACTOR UNITS
8. Menu pointers (for 7)

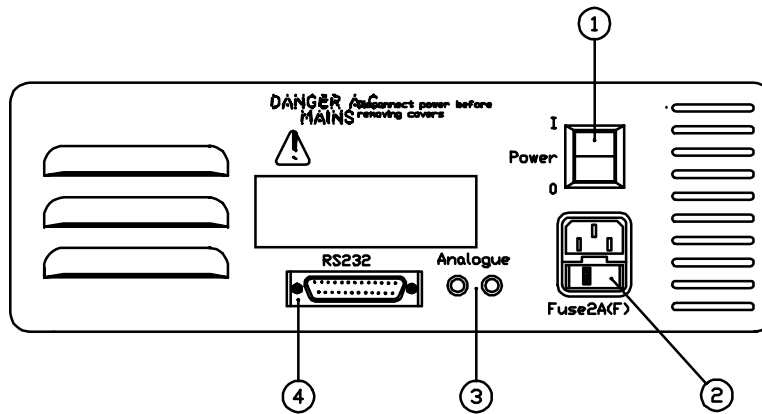
2.4 CONTROLS



1. used to adjust values on the selected display
2. used to move horizontally between menu options
3. used to select the displayed menu option
4. initiates a calibration routine
5. Print key. Provides a printout of the current reading with an incremental sample number. When pressed for the first time after a calibration the print out will give calibration information. The incremental sample number will be reset after a calibration.

2.5 INPUTS/OUTPUTS

Fig. 2.5.1 Rear Panel Layout



- | | |
|---------------------------|---|
| 1. ROCKER SWITCH | On/Off switch for the unit. |
| 2. POWER IN SOCKET | IEC type connection socket for mains cable. |
| 3. OUTPUT SOCKETS | Analogue output. |
| 4. OUTPUT SOCKET | Output socket for (25 way) RS232. |

SECTION 3

OPERATION

3.1 INITIAL SET-UP

NOTE: **If the unit is in continuous use it is recommended that it should be left switched on to obtain maximum lamp life. Do not open the sample chamber door during initialisation.**

Connect the unit to the correct mains supply and switch on. After switch on, the Model S-22 automatically re-aligns the monochromator using the spectral peaks associated with the Xenon flash lamp. During this initialisation, the S-22 displays CAL on the primary display. After calibration, the unit will then go to the last wavelength used and enter the measurement mode last used. The following error conditions, which are displayed for 2 seconds, are possible if the S-22 fails to find the zero order peak:

Err 1 Dark calibration error.

Err 2 Light calibration error.

Err 3 Concentration calibration error.

Err 5 Power on self test error. Unable to detect a peak signal for wavelength calibration. Possible causes are sample left in the sample chamber or lamp failure.

Err 6 Power on self test error. Detector signal with the lamp off exceeds the preset threshold. possible cause is the sample chamber lid left in the open position.

Err 7 Power on self test error. Unable to detect the monochromator reference position sensor. Consult your local distributor.

If a printer is connected pressing the print key will generate a printout of wavelength cal data for GLP requirements. Any potential cal errors will also be shown. Example printout shown on page 7.

Example Printout:

```
=====
S-22 UV/VIS SPECTROPHOTOMETER

OPERATOR .....

TIME:  : :   DATE:  /  /

POWER-ON WAVELENGTH CALIBRATION OK

PEAK AT 246NM CALIBRATED TO 247NM
PEAK AT 530NM CALIBRATED TO 528NM
PEAK AT 822NM CALIBRATED TO 824NM

=====
 1 100.0 %T 500 nm
 2 100.0 %T 500 nm
 3 100.0 %T 500 nm
 4 100.0 %T 500 nm
 5 100.0 %T 500 nm
```

```
=====
S-22 UV/VIS SPECTROPHOTOMETER

OPERATOR .....

TIME:  : :   DATE:  /  /

POWER-ON WAVELENGTH CALIBRATION WARNING

PEAK AT 246NM CALIBRATED TO 247NM
PEAK AT 519NM CALIBRATED TO 528NM
PEAK AT 815NM CALIBRATED TO 824NM

=====
 1 100.0 %T 500 nm
 2 100.0 %T 500 nm
 3 100.0 %T 500 nm
```

3.2 SAMPLE MEASUREMENT

Many methodologies are well documented and where these are available the recommended wavelength should be used. Where a new methodology is being developed, the choice of wavelength can often be approximately determined by choosing an absorbance wavelength that is complimentary in colour to that of the standard solution. The list given below illustrates this point. The chart may be read from left to right or right to left, i.e; a blue sample requires a yellow filter / a yellow sample requires a blue filter.

Blue	-	Yellow
Greenish/Blue	-	Orange
Bluish Green	-	Red
Green	-	Red or Blue

Colours, as they relate to wavelength, can be reviewed by placing a screen, i.e; a piece of card in the S-22 light path where it passes through the sample chamber. It will be seen that 400nm gives blue light and 700nm gives red, with a progression between these points of green, yellow and orange.

NOTE: The human eye is unable to detect wavelengths below 400nm or above 700nm.

Once a complimentary colour has been chosen the precise analytical wavelength needs to be selected. This wavelength will normally be that which gives the maximum absorbance value. This can be selected by scanning in 5nm steps until an optimum is reached. It should be noted that zero absorbance point will change with wavelength. A zero CAL should be carried out whenever the wavelength is changed.

The complimentary colour method of selecting wavelength may not be applicable in all situations, perhaps because the solution has no distinct colour, or the solution is of a complex nature and the absorbing species of interest is not the predominant colour. In these circumstances it will be necessary to scan across the spectrum to determine points of maximum absorbance.

Situations also exist where solutions will absorb at more than one wavelength. If this situation is encountered it is usually best to select the wavelength which gives maximum absorbance.

It is always good practice to verify linearity (i.e; concentration vs reading) of the methodology at the selected wavelength. Where more than one absorbing wavelength is available, it is probable that one will offer better linearity characteristics than others.

To perform measurements the following procedures should be carried out:

Transmission Mode

This mode is selected by moving the cursor to the %T menu using the LEFT or RIGHT arrow keys. The primary display will show the transmittance, with %T units. The wavelength can be adjusted using the UP and DOWN arrow keys. A calibration routine is initiated by pressing the CAL key. The routine performs a 100% transmission calibration. A blank (clear) solution should be used for this calibration procedure.

The following error code is possible after a calibration:

Err 2 Light cal error. This error indicates that there is insufficient light to calibrate to 100%. The most likely cause is that light at the selected wavelength is being absorbed by a sample in the sample chamber. This error can also be caused if the lamp has failed.

A calibration resets the sample number to unity.

Absorbance Mode

This mode is selected by moving the cursor to the ABS mode using the LEFT or RIGHT arrow keys. The primary display will show the absorbance, with ABS units. The wavelength can be adjusted using the UP and DOWN arrow keys. A calibration routine is initiated by pressing the CAL key. The routine performs a 0.000 Absorbance calibration. A blank (clear) solution should be used for this calibration procedure. The possible error condition is the same as for the transmission mode.

Concentration Mode

This mode is selected by moving the cursor to the CONC menu option using the LEFT or RIGHT arrow keys. The primary display will show the concentration, with ppm, mg/l, g/l, M, % or blank units. The wavelength can be adjusted using the UP and DOWN arrow keys. Pressing the CAL key places the S-22 in a concentration cal mode (indicated by the cal annunciator) which allows the UP and DOWN arrow keys to be used to change the displayed concentration to the required value (the wavelength adjust annunciator is extinguished, and the primary adjust annunciator is illuminated). Pressing the CAL or RETURN key calibrates the concentration to the set value by calculating a multiplication factor for the current absorbance. If the factor calculated is out of range, then the instrument will display Err 3 for 2 seconds after the calibration.

The factor can be displayed on the secondary display by moving the cursor beneath the FACTOR menu option. With the factor displayed, the UP and DOWN arrow keys allow the factor to be set directly. Pressing the RETURN or CAL key returns to concentration plus wavelength mode.

The concentration units can be set by selecting the UNITS menu option and then scrolled through by using the UP and DOWN arrow keys (the wavelength adjust annunciator is extinguished, and the adjust annunciator is illuminated, both primary and secondary display will show ---). Pressing the RETURN or CAL key returns to concentration plus wavelength mode.

3.3 GOOD PRACTICE GUIDELINES

1. For optimum performance a calibration routine should be carried out at the beginning and end of every sample batch.
2. To ensure accurate results are obtained the sample area lid should be kept in the closed position during measurement.
3. The styrene cuvettes supplied with the unit are disposable (i.e; ideally they should be used once and then thrown away). Some repeat use is possible, providing extreme care is taken during cleaning, to ensure no damage occurs to the polished surface.

NOTE: The plastic cuvettes supplied with the unit are not suitable for use below a wave length of 310nm.

Other grades of UV plastic cuvettes can be used down to 275nm.

If the unit is being used below this wavelength, UV grade quartz glass cuvettes must be used.

4. UV quartz cells should be used for measurements below 310nm.
5. Plastic cuvettes are not suitable for use with organic solvents.
6. Glassware used in the preparation of standards should be made of a high grade borosilicate glass. The use of soda glass should be avoided wherever possible as leaching can occur during prolonged contact, giving erroneous results.
7. Glass cuvettes should be thoroughly cleaned after use. Discard when scratches become evident in polished surfaces.
8. Chemical reagents should, wherever possible, be of high grade quality. Contamination can cause problems, even at very low levels. Diluents (i.e; water or solvents) must be free from impurities.
9. There are some substances which do not follow Beer's Law. When attempting a new method it is advised that linearity checks should be performed over the range of concentrations being used. This can be carried out by preparing a quantity of known strength solutions and checking the results.
 - a) Deviations from Beer's Law may occur at high concentrations by association of molecular ionic species.
 - b) Deviations from Beer's Law may occur at low concentrations by variation in hydration, introducing changes in the nature of complex ions.
 - c) Absorption which does not obey Beer's Law will require a graph of known standards to be plotted. This should indicate Reading vs Concentration. The reading obtained from the unknowns can then be related to the concentrations from the graph.
10. Samples and standards can "outgas" when left in the cuvette. Bubbles formed on the cuvette walls will cause reading errors.

SECTION 4

MAINTENANCE

4.1 GENERAL

The S-22 has been designed to give optimum performance with minimum maintenance. It is only necessary to keep the external surfaces clean and free from dust. The sample area should always be kept clean and any accidental spillage should be wiped away immediately. To give added protection when not in use, the unit should be disconnected from the mains supply and covered with the optional dust cover (BOE 630 028). For longer term storage or re-shipment it is recommended that the unit be returned to the original packing case.

NOTE: The S-22 Monochromator is a non-serviceable unit and no attempt should be made to repair this item. Failure to observe this recommendation will result in the loss of any Warranty Claim on this product. In the unlikely event of the monochromator requiring service or calibration, it is essential that the Manufacturer or your local Distributor be contacted immediately for advice.

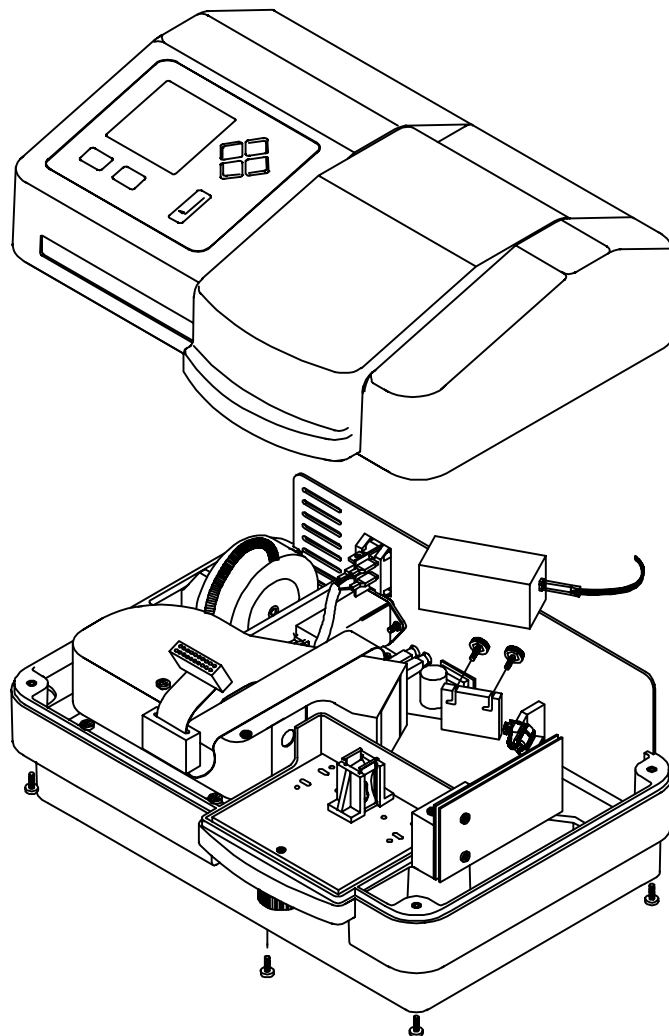
4.2 LIGHT SOURCE REPLACEMENT

The only routine maintenance which may be required is the replacement of the light source if this fails. Failure should be suspected if lamp failure indicator appears on the display. This can be confirmed by looking in the sample chamber. The Xenon Flash Lamp Module is available from the Manufacturer or your local Distributor - refer section 5.2, Spares.

CAUTION: The following safety precautions should be observed prior to attempting the light source replacement procedure.

- 1. DISCONNECT THE UNIT FROM THE MAINS SUPPLY PRIOR TO REMOVING THE TOP COVER.**
- 2. SAFETY GLASSES MUST BE WORN WHEN UV EMISSIONS ARE PRESENT.**
- 3. PROTECTIVE GLOVES SHOULD BE WORN WHEN HANDLING THE REPLACEMENT LAMP TO PREVENT DAMAGE FROM FINGERMARKS.**
- 4. A SUPPLY OF 400 VOLTS IS PRESENT. ALL NORMAL SAFETY PRECAUTIONS SHOULD BE OBSERVED.**

1. Remove the 4 case screws as shown.
2. Lift the top cover clear, taking care not to strain the ribbon cable.
3. Remove the 2 xenon lamp retaining thumb screws.
4. Remove the connector from the rear of the xenon lamp.
5. When replacing the lamp ensure it is pushed fully up into the optics housing before tightening the thumb screws.
6. Refir the top cover, taking care with the ribbon cable. Refit the 4 case screws.



SECTION 5

OPTIONAL ACCESSORIES

5.1 OPTIONAL ACCESSORIES

The following list of items are available as optional accessories for use with the Model S-22:

BOE 630 005	Adjustable Cell Holder
BOE 630 020	Test Tube Holder (12mm)
BOE 630 021	Test Tube Holder (25mm)
BOE 630 022	Test Tube Holder (16mm)
BOE 630 028	Dust Cover

5.2 SPARES

BOE 012 094	Xenon Flash Lamp Module
BOE 060 084	10 x 10mm plastic cuvettes (pack 100)
BOE 060 229	10 x 10mm plastic cuvettes (pack 500)
BOE 016 021	Replacement fuse 2A
BOE 630 004	10 x 10mm Cell Holder

SECTION 6

INTERFACING

Serial Interface

The Model S-22 has a bi-directional RS232 interface set to:

1200 baud
7 data bits
odd parity
1 stop bit

The 25 way D connector allows a standard one-to-one interconnection lead to be used, as supplied with the 40 column printer.

A printout is initiated by pressing the PRINT key. If the sample number is unity, then the printout will include a header block. The sample number is incremented every time the PRINT key is pressed.

The following commands can also be sent to the S-22 via the serial interface (using Windows Terminal or Jensoft, for example).

ASCII D or d	Same as pressing the PRINT key
ASCII T<CR>	Outputs transmission and wavelength separated by an ASCII TAB character, regardless of the S-22 operating mode. For example: 100.0 540
ASCII A<CR>	Outputs absorbance and wavelength separated by an ASCII TAB character, regardless of the S-22 operating mode. For example: 0.001 540
ASCII C<CR>	Outputs concentration and wavelength separated by an ASCII TAB character, regardless of the S-22 operating mode. For example: 123.4 540
ASCII V<CR>	Outputs a voltage proportional to the monochromatic light level passing through the sample and wavelength separated by an ASCII TAB character. For example: 1234.5 540
ASCII Z<CR>	Calibrates a zero absorbance if the Xenon lamp is on (SO<CR> command), or zero transmittance if the lamp is off (SC<CR> command).
ASCII SC<CR>	Switches the Xenon lamp off. This allows 0% transmittance to be calibrated.
ASCII SO<CR>	Switches the Xenon lamp on. This allows 100% transmittance (zero absorbance) to be calibrated. The shutter must be open for normal measurements.
ASCII Gnnn<CR>	Commands the S-22 to go to the wavelength nnm . For example: G540<CR> will set the wavelength to 540nm.
ASCII Fxxxx.x<CR>	Sets the concentration factor to xxx.x. For example: F1000<CR> will set the

factor to 1000.

Note <CR> is an ASCII carriage return character.

The last three commands provide an output which can readily be incorporated into most spreadsheet software packages.

6.2 RS232 Output

The bi-directional RS232 interface is available on the rear panel 25 way D type connector.

The connections are as follows:

TXD 2	- INPUT TO S-22
RXD 3	- OUTPUT FROM S-22
RTS 4	- LINKED TO CTS
CTS 5	- LINKED TO RTS
DSR 6	- OUTPUT FROM S-22
DCD 8	- OUTPUT FRM S-22
DTR 20	- INPUT TO S-22 (must be active)
GND 7	

Suggested interconnections are detailed below:

S-22		IBM PC XT (25 way "D")
TXD 2	_____	2 TXD (From PC)
RXD 3	_____	3 RXD (To PC)
RTS 4	_____	4 RTS (From PC)
CTS 5	_____	5 CTS (To PC)
DSR 6	_____	6 DSR (To PC)
DCD 8	_____	8 DCD (To PC)
DTR 20	_____	20 DTR (From PC)
GND 7	_____	7 GND

S-22		IBM PC XT (9 way "D")
TXD 2	_____	3 TXD (From PC)
RXD 3	_____	2 RXD (To PC)
RTS 4	_____	7 RTS (From PC)
CTS 5	_____	8 CTS (To PC)
DSR 6	_____	6 DSR (To PC)
DCD 8	_____	1 DCD (To PC)
DTR 20	_____	4 DTR (From PC)
GND 7	_____	5 GND

NOTE: The Interface Cable Kit (Order Code: BOE 542 009) can be used to implement the above interconnections.

Recorder Output

This is available via the 4mm rear panel sockets. The level is proportional to the displayed reading, depending on the measurement mode:

Transmission	1mV per 0.1% T
Absorbance	1mV per 0.001ABS
Concentration	1mV per concentration unit

EC Declaration of Conformity

BOECO S-22 Spectrophotometer complies with the following European Standards:

- | | |
|-----------------|--|
| EN 50081-1:1992 | Electromagnetic compatibility - Generic emission standard |
| EN 61326:1998 | Electrical equipment for measurement, control and laboratory use - EMC requirements |
| EN 61010-1:1993 | Safety requirements for electrical equipment for measurement, control and laboratory use |

Following the provision of:

EMC Directive - 89/336/EEC and Low Voltage Directive - 73/23/EEC

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