

**AQUANOVA
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.

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SECTION 1

INTRODUCTION

1.1 INSTRUMENT DESCRIPTION

The Aquanova is a microprocessor controlled Visible Range Spectrophotometer covering the wavelength range of 320 to 1000nm with a 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 Aquanova 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 Aquanova provides a system with fast warm-up, low drift and high reliability.

The Aquanova includes pre-programmed methods for use with sixteen water test kits. Ten user methods can also be saved on the Aquanova to allow use with alternative kits. This product is supplied with a 15mm reaction vial holder and a COD cell holder.

Available Test Kits

Element	Order Code Kit	Element	Order Code Kit
Aluminium	025 200	Iron	025 205
Ammonia	025 201	Nitrate	025 206
Chloride	025 211	Nitrite	025 212
Chlorine free	025 202	Phosphate	025 207
Chlorine total	025 202	Silica	025 208
COD low range	025 213	Sulphate	025 209
COD mid range	025 214	Zinc	025 210
COD high range	025 215		
Copper	025 203		
Fluoride	025 204		

Each kit comes complete with comprehensive instructions, all reagents, 1 reaction vial and measuring scoop.

1.2 INSTRUMENT SPECIFICATIONS

Wavelength:

Range	320 - 1000nm
Resolution	1nm
Accuracy	±2nm
Bandwidth	8nm

Transmittance:

Range	0 to 199.9%
Resolution	0.1%
Stray Light	<0.5%
Photometric Accuracy	±1%

Absorbance:

Range	-0.300 to 1.999A
Resolution	0.001A

Concentration:

Range	-300 to 1999 Concentration
Resolution	0.01/0.1/1
Units	ppm, mg/l, mM, g/l, %, M or none
Factor	0 to 99.99, 100.0 to 999.9, 1000 to 9999

Photometric Noise Levels:

<1%

Photometric Stability:

1%/Hr after warm-up

Readout:

Custom LCD Graphics display

Outputs:

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

Light Source:

Tungsten Halogen 20W 12V

Input Voltage:

115/230Vac -20% + 10% 50/60Hz

Input Power:

<50W

Size:

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

Weight:

6Kgs

SECTION 2

INSTALLATION

2.1 UNPACKING

Remove the Aquanova from the packaging and ensure the following items are present:

1. Aquanova Spectrophotometer
2. Mains Cable
3. Pack 8 Cuvetubes (060 381)
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 Aquanova 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

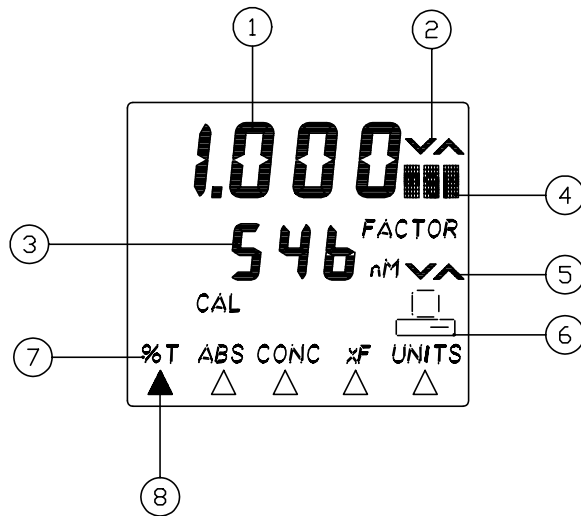
A suitable plug should be connected to the 3 wires on the mains lead. These are colour coded to conform to the internationally recognised standard such that:

BROWN	LIVE
BLUE	NEUTRAL
GREEN/YELLOW	EARTH

IMPORTANT: THE UNIT MUST BE EARTHED.

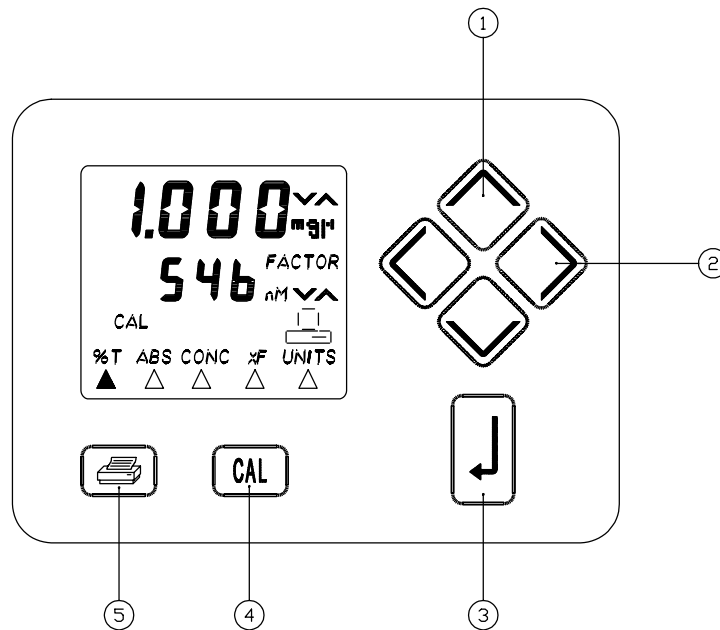
The Green/Yellow wire in the a.c. supply cable must be connected to a properly grounded terminal.

2.3 DISPLAYS



1. Primary display area - Transmission, Absorbance, Concentration
2. Primary display adjust annunciator
3. Secondary display area - Wavelength, Factor, Method
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)

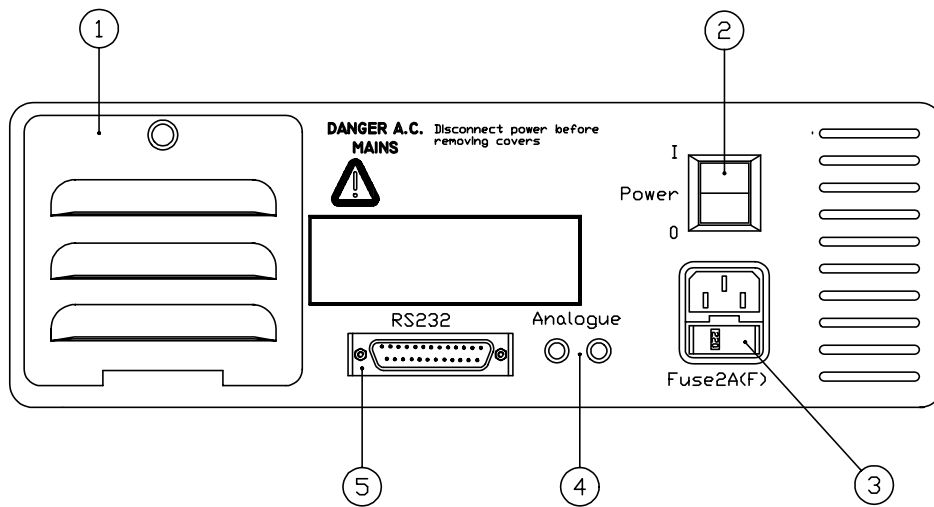
2.4 CONTROLS



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. LAMP ACCESS PANEL This panel allows the user to gain access to the tungsten halogen lamp when replacement is necessary.

NOTE: The Lamp Access Panel and all ventilation slots must not be covered or obstructed at any time.

2. ROCKER SWITCH On/Off switch for the unit.

3. POWER IN SOCKET IEC type connection socket for mains cable.

4. OUTPUT SOCKETS Analogue output.

5. 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 Aquanova automatically re-aligns the monochromator at zero order wavelength. During this initialisation, the Aquanova displays CAL on the primary display and a moving dash on the secondary display. After calibration, the unit will then go to the last wavelength used and enter the measurement mode last used i.e. %T, ABS or Conc. The following error conditions are possible if the Aquanova fails to find the zero order peak:

Err 4 Low zero order light level detected. The instrument has failed to find a zero order peak. Possible causes of this error are that the lamp has failed or that a sample has been left in the unit which is absorbing the zero order light.

Err 5 No light level detected. The instrument has failed to find a zero order peak. Possible causes of this error are that the lamp has failed or that a sample has been left in the unit which is absorbing the zero order light.

Err 6 No dark level detected. The instrument checks the region below 320nm which should have no optical throughput. If this region cannot be found the most likely cause is that the sample chamber lid is not closed.

3.2 SAMPLE MEASUREMENT

The Aquanova has fourteen pre-programmed methods, relating to the Colorimetric Test Kits available from Jenway, and ten user definable methods. The pre-programmed methods are listed inside the sample chamber lid. Each method has a pre-calculated factor for the calculation of the concentration from the absorbance reading. The Aquanova will also automatically convert the molarity readings from mg l^{-1} using the molecular weight of the substance being tested.

Use of the Pre-programmed Methods (P200-P215 & t202)

The methods are selected by moving the cursor to the CONC menu option using the LEFT or RIGHT arrow keys. The primary display will show concentration with ppm, mg l^{-1} or mM. The required method can then be selected using the UP and DOWN arrow keys. The correct wavelength for the method will automatically be selected. Transferring to the ABS or %T menu option using the LEFT or RIGHT arrow keys will display the wavelength of the method.

Prior to analysis of unknown samples the Aquanova must be calibrated using at least two standard solutions of known concentration, one of which must be a blank (a sample of distilled water treated as the samples). These standards need to be made accurately for the Aquanova to perform to specification**. Comprehensive instructions are supplied with each individual colorimetric test kit and should be followed accurately.

With the blank sample in the sample chamber and the Aquanova in the CONC, %T or ABS menu options, pressing the CAL key will initiate a calibration routine. The routine performs a zero % transmission calibration followed by a readout of 100% T, 0.000AABS or 0.00 "units of concentration". (An internal

** An exception to this is the COD methods (P213-215) for which the standards are not necessary, and a blank is not possible for methods P214 and P215. For these methods (P213-215) the calibration routine is carried out with no reaction vial in the sample chamber.

Note: When making Fluoride measurements please refer to the instruction sheet supplied with the kit (025 204) for correct calibration routine.

shutter is automatically activated to perform the zero % setting and this part of the routine is, therefore, independent of the solution in the light path).

The following error codes are possible after a calibration:

Err 1 Dark cal error. This error occurs when the Aquanova closes the shutter to block light entering the sample chamber. If the detector output does not fall to a level normally associated with a dark cal then this error is indicated. The most likely cause is that the sample chamber lid is not closed.

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.

A known sample reading is advised to check both the factor and the accuracy of dilution. The known sample is placed in the sample chamber and the concentration read. If it is not correct the factor can be adjusted to give the correct reading by transferring to the xF menu option using the LEFT and RIGHT arrow keys, and then using the UP and DOWN arrow keys to change the factor. When the instrument is switched off the factor will return to its default factory setting.

The Aquanova is now ready to analyse the unknown samples.

Use of the User Definable Methods (U001 to U010)

The next available user method is selected by moving the cursor to the CONC menu option and then using the UP and DOWN keys. All the user methods have a default wavelength of 540nm and a factor of 1.00. The wavelength can be adjusted by moving the cursor to the %T or ABS menu options using the LEFT or RIGHT arrow keys, and then using the UP and DOWN arrow keys.

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 user method number.

NOTE: If developing your own methodology select the next available user method (U.001 to U.010) to ensure that the wavelength and calibration factor are retained by the instrument.

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 Aquanova 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.

With the blank sample in the sample chamber and the menu option set to %T, ABS or CONC, pressing the CAL key will initiate the calibration routine. The routine performs a zero % transmission calibration followed by a readout of 100%T, 0.000ABS or 0.00 "units of concentration". (An internal shutter is automatically activated to perform the zero % setting, and this part of the routine is, therefore, independent of the solution in the light path).

The following error codes are possible after a calibration:

Err 1 Dark cal error. This error occurs when the Aquanova closes the shutter to block light entering the sample chamber. If the detector output does not fall to a level normally associated with a dark cal then this error is indicated. The most likely cause is that the sample chamber lid is not closed.

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.

With a solution of known concentration in the sample cell and the menu option set to xF, the factor can be adjusted so that the concentration readout is correct.

The user definable method is now ready to measure unknown samples.

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.
4. Plastic cuvettes are not suitable for use with organic solvents.
5. 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.
6. Glass cuvettes should be thoroughly cleaned after use. Discard when scratches become evident in polished surfaces.
7. 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.
8. 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.
9. 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 Aquanova 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 (630 028). For longer term storage or re-shipment it is recommended that the unit be returned to the original packing case.

NOTE: The Aquanova 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 Tungsten Halogen lamp is available from the Manufacturer or your local Distributor (refer Section 5.2, Spares).

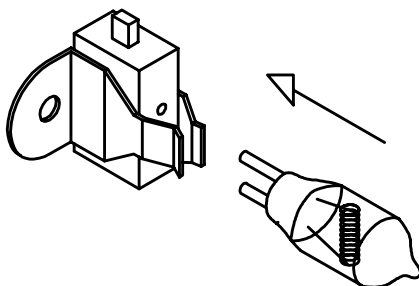
WARNING: Disconnect the unit from the mains supply prior to replacing the lamp. Care should be taken when removing the lamp from the holder. Ensure the lamp is cool prior to handling.

1. Access to the tungsten halogen lamp can be gained via the lamp access panel, located at the rear of the unit (refer Section 2.4).
2. Slacken off the thumbscrew from the lamp access panel located at the rear of the Aquanova.
3. Remove the old lamp from the holder. The lamp is a plug-in fit and should be removed by gently easing it from the holder.

IMPORTANT: When fitting the replacement lamp it is essential that the glass envelope is not touched. Finger marks will damage the lamp. Should accidental damage with finger marks occur, the surface of the lamp may be cleaned using iso-propyl alcohol.

4. Carefully remove the replacement lamp from the packaging, ensuring the glass portion of the lamp is not touched.
5. Insert the lamp into the holder, as illustrated, ensuring that it is fully pushed home.

Fig. 4.2.1 Lamp Fitting



6. Close the lamp access panel and re-tighten the thumbscrew.

NOTE:

It is essential that only the specified replacement lamp should be used. Accuracy of optical alignment and performance cannot be guaranteed using alternative manufactured lamps.

SECTION 5

OPTIONAL ACCESSORIES

5.1 OPTIONAL ACCESSORIES

The following list of items are available as optional accessories for use with the Aquanova :

630 004	10x10mm Cell Holder
630 028	Dust Cover
050 002	Data Acquisition Software - 3½" disk
060 381	Pack 88 reaction vials for use with Test Kits
630 005	Adjustable Cell Holder
035 079	100 x 10mm glass cell
035 087	50 x 10mm glass cell
035 029	40 x 10mm glass cell
035 086	20 x 10mm glass cell
035 027	10 x 10mm glass cell

5.2 SPARES

012 041	Tungsten Halogen Lamp
016 021	Replacement fuse 2A
016 025	Replacement fuse 1A

SECTION 6

INTERFACING

6.1 Serial Interface

The Aquanova 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 Aquanova 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 Aquanova operating mode. For example: 100.0 540
ASCII A <CR>	Outputs absorbance and wavelength separated by an ASCII TAB character, regardless of the Aquanova operating mode. For example: 0.001 540
ASCII C <CR>	Outputs concentration and wavelength separated by an ASCII TAB character, regardless of the Aquanova 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 dark shutter is open (SO<CR> command), or zero transmittance if the dark shutter is closed (SC<CR> command).
ASCII SC <CR>	Closes the dark shutter which blocks monochromatic light entering the sample chamber. This allows 0% transmittance to be calibrated.
ASCII SO <CR>	Opens the dark shutter which allows monochromatic light to enter the sample chamber. This allows 100% transmittance (zero absorbance) to be calibrated. The shutter must be open for normal measurements.
ASCII G <i>nnn</i> <CR>	Commands the Aquanova 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 xxxx.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 AQUANOVA
RXD 3	- OUTPUT FROM AQUANOVA
RTS 4	- LINKED TO CTS
CTS 5	- LINKED TO RTS
DSR 6	- OUTPUT FROM AQUANOVA
DCD 8	- OUTPUT FRM AQUANOVA
DTR 20	- INPUT TO AQUANOVA (must be active)
GND 7	

Suggested interconnections are detailed below:

AQUANOVA		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

AQUANOVA		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: 542 009) can be used to implement the above interconnections.

6.3 Analogue 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

Jenway Aquanova Spectrophotometer complies with the following European Standards:

EN 50081-1:1992	Electromagnetic compatibility - Generic emission standard
EN 50082-1:1992	Electromagnetic compatibility - Generic immunity standard (Performance criterion B)
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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