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# **NOVO-PAC**

**Automatic Hiding Power Meter**

Also featuring:

**NOVO-SOFT** - Windows based PC software

# ***OPERATING INSTRUCTIONS***

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Manufactured in the UK by:

**RHOPOINT INSTRUMENTATION LTD**



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**NOVO-PAC**

Software version 1.04 up

Changes are periodically made to the information herein, these changes will be incorporated in any future editions of this publication.

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## 1 INTRODUCTION

Congratulations on purchasing a Rhopoint™ NOVO-PAC, the most technically advanced portable opacity meter in the world. Features include:

- Machined aluminum optical block - ensures the integrity of the  $\pm 0.1^\circ$  angular tolerance specified by some measuring standards
- Auto-stabilisation circuit - this unique feature, patented by Rhopoint™, allows continuous readings to be made, and also compensates for filament sag in the lamps when reading with the instrument sideways or upside-down
- Automatic internal calculation of contrast ratio/hiding power
- Memory for 40 batches of contrast ratio readings
- Full statistics showing minimum, maximum, mean, standard deviation and coefficient of variation of stored values
- RS232C Output with Windows based PC software or printer available
- Capability to operate in any one of six languages (English, Français, Deutsch, Italiano, Español or Nederlands)

Your instrument is supplied in a lightweight carry case, the contents of which are as follows:

1. NOVO-PAC unit
2. NOVO-PAC White pad (high reflectance) and black glass (zero) calibration standards in wooden box
3. 100  $\mu\text{m}$  (0.004") paint spreader
4. Glass test bed
5. Opacity test cards (10)
6. NOVO-SOFT 3¼" floppy diskette
7. Serial RS232 PC interface cable
8. Guarantee card - fill in and return for free extended warranty
9. Operating instructions
10. Battery charger
11. Spare lamp
12. Cleaning cloth

Rhopoint™ NOVO-PAC is both accurate and user friendly, allowing Statistical Process Control of hiding power to be conducted quickly and easily at any location.

We recommend that the whole of this manual is read before commencing measurements. These instructions should be read with the instrument conveniently to hand, and assume that the unit is working in English.

## 2 GETTING STARTED

### 2.1 Battery Charging

The battery charger for your NOVO-PAC plugs into the aperture marked **DC**. It is important to connect the charger to the instrument before switching on the mains. The unit is initially supplied without power, and will take 16 hours to fully charge. It is possible to operate the instrument whilst it is on charge, but readings will fluctuate slightly and obviously charging time will increase. To maximise the lifetime of the batteries, the instrument should be operated until the low battery warning is observed in the LCD.

### 2.2 Instrument Front Control Panel

Figure 2.2.1 shows the front panel of the NOVO-PAC, which is controlled by six buttons.

<input type="checkbox"/> Delete Reset	<b>NOVO-PAC</b>	Cal↑ Batch <input type="checkbox"/>
<input type="checkbox"/> Stats 2nd		Cal↓ Output <input type="checkbox"/>
<input type="checkbox"/> On/ Black	<b>Automatic Hiding Power Meter</b>	On/ White <input type="checkbox"/>

*Fig. 2.2.1. NOVO-PAC control panel*

As can be seen, all buttons have two functions, the primary function is shown in normal text, the secondary function is shown in reverse text. The second function is operated by first pressing the 2nd function button, and then the appropriate dual function button, similar to a pocket calculator. For example, to activate the RESET function you would press the Stats/2nd button, followed by the Delete/Reset button. This would be written in the text in this manual as 2nd/RESET.

### 3 SAMPLE PREPARATION

#### 3.1 Definitions

Hiding Power - Bulk property of a paint relating to how opaque films formed are, independent of film thickness.

Opacity - Property of a *film* relating to how opaque it is, dependent on film thickness.

Contrast Ratio ( $C_w$ ) - A measure of opacity. The extent to which a paint film obscures the contrasting features of a test substrate. Expressed as the ratio of reflectance over the black ( $R_0$ ) and white ( $R_w$ ) areas of a standard test substrate, i.e.,

$$C_w = \frac{R_0}{R_w}$$

Standard Test Substrate (STS) - Black and white test cards divided into halves, one black, one white. The black area has a reflectance  $\leq 1\%$ , the white area has a reflectance ( $W$ ) of  $80 \pm 1\%$ . Contrast ratio when white area is 80% is written as  $C_{0.80}$ .

$$\therefore C_{0.80} = \frac{R_0}{R_{0.80}}$$

As test cards are often have a  $W$  outside the 1% tolerance, one of two following equations can be used to adjust measured values to real  $C_{0.80}$  data.

$$C_{0.80} = \frac{WC_w(1 - 0.80R_0)}{C_w(W - 0.80) + 0.80(1 - WR_0)}$$

$$C_{0.80} = \frac{WR_0(1 - 0.80R_0)}{R_0(W - 0.80) + 0.80R_w(1 - WR_0)}$$

#### 3.2 Substrate Preparation

The Standard Test Substrate should be stored singularly for at least 24 hours under the conditions of testing, i.e.  $23 \pm 2$  °C and  $50 \pm 5$  % relative humidity. Cards should be handled at all times by the edges only. Before coating the card must be held flat either on a flat glass plate (6 mm min. thickness), fixed at one end with clips or adhesive tape, or on a vacuum suction plate which must be flat to  $\pm 2$   $\mu\text{m}$ .

### 3.3 Film Preparation

Before application the test paint should be mixed thoroughly to break down any thixotropic structure, but taking care not to generate air bubbles. About 2 ml of paint should be applied in a line across the STS, and spread immediately by drawing down smoothly with the block applicator at an approximate rate of  $10 \text{ cm s}^{-1}$ . The block applicator produces a wet film of  $100 \mu\text{m}$  thickness, which is specified by such standards as ISO 2814, and is the approximate thickness at which architectural paint is applied.

The card must be kept flat and horizontal whilst the paint dries, taping the edges if necessary. Films should be conditioned by storing in a standard test environment ( $23 \pm 2 \text{ }^\circ\text{C}$ ;  $50 \pm 5 \%$  relative humidity) for  $>16 \text{ h}$  and  $<168 \text{ h}$  before reflectance measurements are made. After this conditioning period the cards are ready for testing. At least three films should be prepared for each paint sample.

## 4 INSTRUMENT OPERATION

These instructions should be read in conjunction with the reference card or the unit conveniently to hand, and assume that the unit is working in English.

### 4.1 Power Up

Hold and release either the black or white ON button. The instrument will power up with a display showing the instrument type, and manufacturer, e.g.:

NOVO-PAC Rhopoint Instrumentation
--------------------------------------

There is a short delay of 5-6 s whilst the instrument boots. When the instrument is ready to operate the display will change to a format similar to that below:

Data set ID for an opacity calculation	Number of stored readings made over black/white part of STS	Reflectance level of last measured area
↘	↓	↙
Batch 1	Black 1	Reflectance 80.2

The unit will automatically power down approximately 2 minutes after the last button is pressed. To re-activate the instrument, the ON button will need to be pressed again.

### 4.2 Taking Readings

The NOVO-PAC is an advanced type of reflectometer. Reflectometers work by shining a beam of light on to a surface, and measuring how much is reflected. Readings are taken over the area covered by the aperture on the base of the instrument. When the instrument is stood on a surface the aperture can be pinpointed by the intersection of the arrows marked at the bottom of the instrument case on the front and on the sides.

To take a reading press either the black button, if over the black area of the STS, or the white button if over the white area of the STS. It is very important the correct button is pressed, as this information is used to make the opacity calculations. The unit will now start to take a reading, with the colour of the button being pressed shown in the middle column. Whilst the button is held the unit will continually update the current reading. It is recommended that the button is held until a stable reading is observed. When the button is released the value shown in the display at that moment will be entered into memory. The value of the reading will be the same, whether the black or white button is pressed, and the

appropriate number of stored readings will increase by one, as shown in the middle column of the display. All readings on NOVO-PAC are given in Reflectance Units (%), also defined by appropriate standards (e.g. ISO 2814). Basically, 0% represents a perfect black surface, and 100% represents a perfect white surface. Some luminescent materials may exhibit a reflectance of >100%.

The sequence of events on the display is as follows:

*Initial Display*

Batch	Black	Reflectance
1	1	80.2

*Black Pressed*

Batch	Black	Reflectance
1	1	79.5

*Black Held*

Batch	Black	Reflectance
1	1	79.5

*Black Released*

Batch	Black	Reflectance
1	2	79.5

Holding down either the black or white button will continually monitor the reflectance level. If the unit is simultaneously moved across a sample (i.e. at the *Black Held* stage), the operator will quickly be able to ascertain the reflectance variation of the surface under investigation. This enables anomalous areas to be identified easily without the need to take numerous individual readings, and is a feature unique to Rhopoint™ Statistical instruments.

When the button is released, the value currently displayed is stored, and all the Statistical information is updated automatically.

Note that if the instrument is to be used just as a reflectometer, either the black or the white button may be pressed to take readings.

### 4.3 Hiding Power Measurement

To conduct hiding power measurements according to ISO 2814, samples should be prepared as described in section 3. A *minimum* of four readings should be taken on the sample over each of the black and white sections of the STS. These readings may be taken in any order, so long as the WHITE button is pressed when reading over the white part of the STS, and the BLACK button is

pressed to take readings over the black part. For example, you may take two white readings, followed by three black readings, another four white readings, and finish with two black readings. The total number of black and white readings does not need to be equal, as long as at least four of each are taken. Calculations can be made with as little as just one black and one white reading, but the results will be prone to experimental artifacts, and will not have been recorded in accordance with the standard.

Once the desired number of readings has been taken, the 2nd/BATCH button should be pressed. The instrument will then automatically calculate the hiding power, using the following equation:

$$\text{Hiding Power} = \frac{R_b}{R_w} \times 100\%$$

Where  $R_b$  is the mean of all black readings, and  $R_w$  is the mean of all white readings.

*Initial Display*

Batch	White	Reflectance
9	5	81.4

*2nd/Batch Pressed*

Batch	R <sub>b</sub>	R <sub>w</sub>	H. Power
9	71.0	83.6	84.9%

To begin a new batch of readings, simply place the instrument on the next prepared STS and press either the BLACK or WHITE buttons. The batch number will increment by one, and readings can be taken as normal.

#### 4.4 Deleting Data

In the event of an anomalous or accidental reading the last value stored can be deleted. This is achieved by pushing the grey DELETE button at the back left of the control panel. Pressing the button a second time will remove from memory all data for that particular batch. Pressing the button a third and subsequent times will one by one remove all complete batches from memory in the reverse order to that in which they were stored.

The sequence of events on the display is as follows:

*Initial Display*

Batch	Black	Reflectance
4	3	80.2

*Delete Pressed/Released*

Batch	Black	Reflectance
Black	sample	deleted

*Delete Pressed/Released*

Batch	Black	Reflectance
Batch 4	deleted	

*Delete Pressed/Released*

Batch	Black	Reflectance
Batch 3	deleted	

To delete ALL of the readings stored in memory in a single operation, the reset function is used. This is done by pressing the 2nd/RESET button, which will prompt you with the message:

Delete all batches ??? Press WHITE to accept.
--

Pushing the white button will confirm the operation and all data stored in memory for both the current batch and previous batches will be deleted, displaying the message "All data reset." Pushing any other button will cancel the operation and result in no data being deleted.

#### 4.5 Calibration

Instrument calibration should be checked regularly, adjusting if necessary. Before commencing, check that the standard tile is clean, in good condition, and has a valid calibration certificate. Position the instrument on the tile and take a reading (either black or white button may be used). Compare the value displayed with the value assigned to the tile for the matching measurement angle. If the values differ by more than  $\pm 0.5\%$  it will be necessary to adjust the calibration. This should be done with the instrument in place on the tile. Holding the CAL  $\uparrow$  button will incrementally increase the displayed value, whilst the CAL  $\downarrow$  button will decrease it. Releasing the button will set calibration at the value currently displayed. Once the calibration has been adjusted to the appropriate level it can be checked by pressing the READ button again. The calibration value is stored in memory when the unit powers down, so there is no need to re-calibrate each time the instrument is switched on. The calibration configuration of Rhopoint™ Statistical instruments allows calibration using any standard.

e.g. if calibration too high

*Initial Display*

Batch	Black	Reflectance
1	1	99.5

*Cal ↓ Held . . .*

Calibration Down Reflectance 99.4
--------------------------------------

*. . . Cal ↓ Held*

Calibration Down Reflectance 97.2
--------------------------------------

*Cal ↓ Released*

Calibration Down Reflectance 97.2
--------------------------------------

#### 4.6 Statistics

Holding down the yellow STATS button for about 1 second will divert the instrument into statistics mode.

In statistics mode the display shows the minimum (MIN), maximum (MAX) and mean (MEAN) values of the complete batches of data currently stored. If the STATS button is continually held down, or held again whilst in statistics mode, the display scrolls to the left so that the angle and minimum are no longer shown, and the standard deviation of the stored data appears at the right of the display. Releasing the STATS button scrolls the text back to the right again, reverting to the normal statistics display.

*Initial Display*

Batch	White	Reflectance
9	3	85.0

*Stats Held & Released*

Batch	Mean	Max	Min
8	86.7	99.7	78.8

*Stats Held*

Max	Min	CV	SD
99.7	78.8	0.0	7.9

*Stats Released*

Batch	Mean	Max	Min
8	86.7	99.7	78.8

Statistics mode may be exited by pressing the STATS button once (activating the 2nd function), and then a second time. Alternatively, pressing any of the function keys, such as WHITE or OUTPUT, will exit statistics mode and perform that function. If the instrument powers down whilst in statistics mode it will automatically return to normal mode on powering up again.

If statistics mode is entered midway through collecting data for a batch, only data for previous complete batches is taken into

account. You may resume gathering data within this batch by taking readings as normal.

Definitions of instrument statistics are shown below. For this purpose the individual Hiding Power batch results are defined as values  $x_1, x_2, \dots, x_n$ , and  $x_i$  is any data point:

- Statistical sample population,  $n$  - the current number of stored readings (STORE), on which the statistical analysis is based.
- Maximum (MAX) - the highest reading.
- Minimum (MIN) - the lowest reading.
- Mean (MEAN),  $\bar{x}$  - The sum of all readings divided by the total number,  $\bar{x} = \sum_{i=1}^{i=n} \frac{x_i}{n}$
- Standard deviation (SD),  $s$  - Square root of the sum of squared deviations from the mean,  $s = \sum_{i=1}^{i=n} \left( \frac{x_i^2 - \bar{x}^2}{(n-1)} \right)^{1/2}$
- Coefficient of variation (CV),  $c$  - Standard deviation divided by the mean, a measure of data scatter,  $c = \frac{s}{\bar{x}} = \sum_{i=1}^{i=n} \frac{n}{x_i} \left( \frac{x_i^2 - \bar{x}^2}{(n-1)} \right)^{1/2}$

#### 4.7 Output Data

Pressing 2nd/OUTPUT will send all the data in memory to the RS 232C output port, to which either a PC running NOVO-SOFT or a serial printer may be connected. Each data point is briefly displayed as it is output, even if no interface hardware is connected. This is useful if you wish to quickly scan through all the data currently in memory. The display will revert to normal mode on completion.

## **5 PRINTER OR COMPUTER SETTINGS**

### **5.1 NOVO-SOFT**

Interfacing your NOVO-PAC with a PC is simple when using NOVO-SOFT, a Windows based software package specially written by Rhopoint™ for handling reflectance data. Version 1.5 is available from your instrument supplier, and full instructions are given in section 9.

When running, NOVO-SOFT will automatically collect data from your instrument via a serial port, and can collect up to 999 readings. Data may be plotted, in order of measurement, in either a standard 2D, or eye-catching and easy to analyse 3D form. Statistical graphs in the form of a histogram or normal distribution are also possible. Full numerical statistical analysis can be made on the entire sample population, with the option to either delete data, or only work with a selected portion. Data files may be stored on a hard drive, allowing permanent records to be kept, and hard copies may also be produced. There is also a report producing facility which allows graphs, experimental notes and statistical analyses to be printed. Data can also be exported to other packages, such as Lotus or Excel. Future versions of the software are planned which will include batching facilities, and simultaneous analysis.

### **5.2 Configuration of computer**

Instead of using NOVO-SOFT you may wish to interface your instrument with a PC using an alternative method. The instrument outputs data serially at 4800 baud, 8 data bits, 1 stop bit and no parity. Using the RS232 lead supplied it is possible to download data into a MS DOS based computer having set up the computer using the following command:

```
Mode Com2:48,n,8,1
```

If you are using a communication port other than Com2, then you will need to amend this command accordingly. It is now possible to download data directly into any appropriate software.

### **5.3 Configuration of printer**

Your instrument is also capable of directly driving a serial printer, such as that available from Rhopoint™. Please note that your printer must have line feeds enabled with carriage returns, otherwise all data will be printed in the same place and be illegible (see printer hand book). If the OUTPUT function is engaged, all data stored in memory will be printed. Alternatively, it is possible to print measurements as they are taken.

## 6 CHANGE LANGUAGES

Your instrument is configured to operate in one of six languages - English, Français, Deutsch, Italiano, Español or Nederlands. Usually it is set to the language most relevant to the country of supply, but it can be changed to another, if preferred.

To prevent accidental change, the language is set by means of internal dip switches. To change language, follow the instructions below:

1. Ensure the mains lead is disconnected from the supply.
2. Remove the four crosshead screws from the bottom of the case.
3. Slide the bottom of the case off.
4. Locate the bank of four dip switches located by the mounting pillar at the front right corner of the central PCB.
5. Use a blunt instrument, such as a pen, to push the numbered dip switches to the required positions, as indicated in the table below. 'Up' is away from you, 'down' is towards you.

Language	Switch 1	Switch 2	Switch 3	Switch 4
English	down	down	down	down
Français,	down	down	down	up
Español	down	down	up	down
Deutsch,	down	down	up	up
Italiano	down	up	down	down
Nederlands	down	up	down	up

6. Once the required language is selected, replace the instrument case and retaining screws.

The instrument will now operate in the new language. To change the language again, repeat the steps above.

## 7 TROUBLE SHOOTING & SIMPLE REPAIRS

The Rhopoint™ NOVO-PAC is designed to be field serviceable, and much of the maintenance can be performed without returning the instrument to your supplier. If you require assistance in self-servicing, please either contact your supplier, or Rhopoint™ direct, stating the following:

1. Instrument type
2. Serial number
3. Exact nature of fault

### 7.1 Diagnosis

The most common problems are shown below:

SYMPTOM	POSSIBLE CAUSE	ACTION REQUIRED
LCD display blank	NiCad battery flat	either recharge instrument or operate using mains adapter
	faulty charger	if possible check output of charger using a voltmeter
	blown internal fuse	replace square black fuse located at rear of lower PCB, just over one third distance from left (see section 7.4 for PCB removal)
	fault on PCB	remove the PCB's to identify which appears defective, and replace (section 7.4)
erratic, rapidly fluctuating readings	blown lamp	replace lamp (section 7.3)
reads low or zero	dirt/dust on optics	clean with compressed air or soft cloth

### 7.2 Case removal and refitting

1. Ensure the mains lead is disconnected from the supply.
2. Remove the four crosshead screws from the bottom of the case.
3. Slide the bottom of the case off.
4. Refitting is reverse of removal.

### 7.3 Lamp replacement

1. Remove instrument case (section 7.2).
2. Identify the blown bulb, which will have a broken filament, and may also be blackened. Remove the two retaining screws (fig. 7.3.1), so that it may be released.

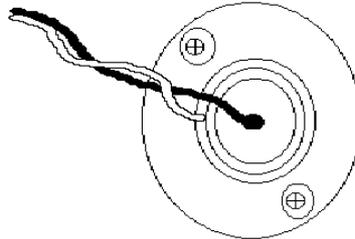


Fig. 7.3.1. Bulb retaining screws.

3. Fit the new bulb, aligning it so that the filament is perpendicular to the angle at which the beam will be directed (fig. 7.3.2).

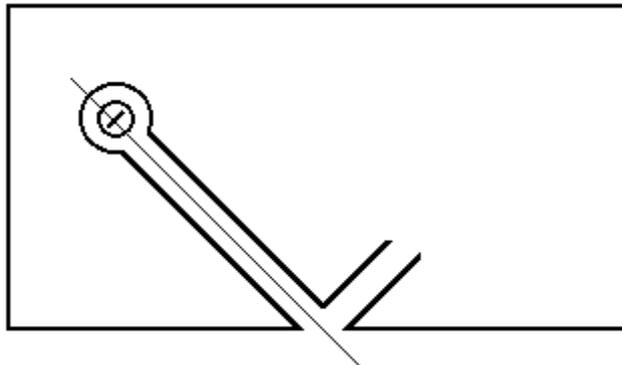


Fig. 7.3.2. Perpendicular filament alignment.

4. Replace and tighten the two retaining screws.
5. With the case still off, power on the unit.
6. Place the instrument on a calibration tile and hold down either the BLACK or WHITE read buttons. Use a small screwdriver to adjust the (R51) internal calibration screw, located at the left hand end of the bottom PCB (fig. 7.3.3).

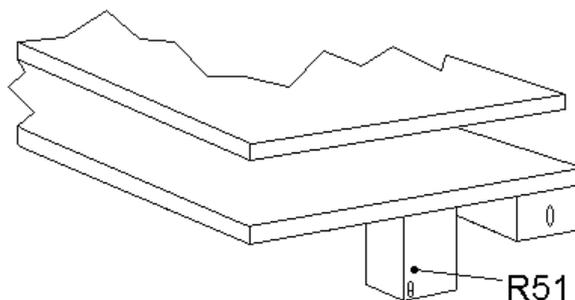


Fig. 7.3.3. Location of Calibration screws on bottom PCB.

7. When the correct value is reached, do not adjust the screw any further, and release the BLACK/WHITE button.
8. Refit case.

#### **7.4 PCB replacement**

1. Remove instrument case (section 7.2).
2. Remove the three screws in the corners of the top PCB, which holds the LCD.
3. Hold the top PCB at the far left end (battery pack facing you) with one hand, and grip the middle board beneath where you are holding with the other. Ease off the top PCB by pulling straight up and gently rocking back and forth.
4. Remove the three crosshead screws from the central PCB (two are located at right of board, between switches; one is located in the centre of the board, a third of the way from the left). Both the central and bottom PCB will now be loose.
5. Separate the central PCB from the bottom PCB by easing apart the connection at the front left of the boards.
6. Faulty boards are usually identified by burned tracks or components, and should be replaced with a new one, available from your supplier. Blown fuses may be replaced by de-soldering the faulty part, and soldering in the new one.
7. Refitting of boards is reverse of removal, but be sure that the fibre washers are correctly replaced.

#### **7.5 Software version**

The software version of your instrument is displayed for a few seconds before power down. Instruments from 1997 onwards are running EEPROM version 2.00 and up.

## **8 NOVO-SOFT VERSION 1.5**

### **8.1 Introduction**

#### *8.1.1 About NOVO-SOFT*

NOVO-SOFT was originally produced at the request of existing users of surface appearance measuring instruments, and many of the programs features were requested. It is the policy of Rhopoint Instrumentation Ltd to meet customer demands, so if there are further features you would like included in future versions of NOVO-SOFT, please contact us and we will be glad to help.

NOVO-SOFT Helpline

 **+44/0 1424 214291**

Dr Graham Sewell or Mr Barry Ingham

Version 1.5 of NOVO-SOFT was released on 14 April 1997.

#### *8.1.2 Installation*

NOVO-SOFT requires a minimum of 3.4 MB of hard disk space. It may be installed by typing the following command from Run in the Windows File Menu:

a:\install.exe

An image of an appearance measurement being taken from a car will appear, and you will be prompted for further information on where you wish the software installed.

#### *8.1.3 Sample Data*

To enable you to test some of the features of NOVO-SOFT before down-loading any real data, two files containing sample data are installed with the software. They are labeled test1.res and test2.res, and are found in the 45 degree sub-directory. To open them you must first be in the NOVO-SOFT Results window.

### **8.2 Configuration**

#### *8.2.1 Communications Connections*

Connect the jack plug end of the RS232 interface cable to the NOVO-PAC output port, and the 9 pin connector to a spare Coms port at the rear of your PC.

#### *8.2.2 Software*

On running NOVO-SOFT for the first time you will directed straight into the Quick Start help function. The help function may be exited from either the File Menu or by pressing Alt+F4. This will send you

to the *System Window*, featuring the yellow sports car, which you will enter directly on running NOVO-SOFT on all future occasions.

From the *System Window* select the Configure option from the Mode Menu, which can be done simply by pressing the \_ button. This will open the *Configuration Window* (fig. 8.2.3). Using the mouse select the Coms port to which you have connected to the interface cable, and indicate the type of instrument you are using, i.e. NOVO-PAC.

Once you click OK all settings will be adjusted and saved for when you next run NOVO-SOFT. You are now ready to down load data.

### 8.2.3 Configuration Window

The *Configuration Window* (fig. 8.2.3) is reached either from the Mode Menu in the *System Window* or by pressing the \_ button. If, when saving data in NOVO-SOFT format, you also wish to simultaneously save it in a comma delimited format, check the Save \*.CSV files box also. Files will have the same name as that selected for the NOVO-SOFT data, only with the \*.CSV file extension. Data can also be exported at any time during editing and analysis using the Export option in the *Results Window*.

The Document Header box contains the text that will be printed at the top of reports, and may be adjusted by the user, as desired.

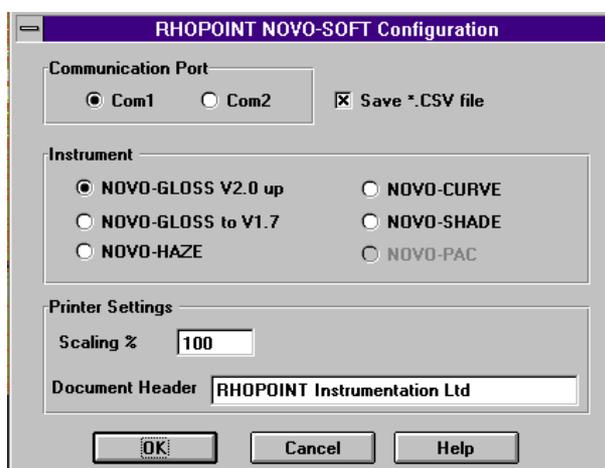


Fig. 8.2.3. The *Configuration Window*.

## 8.3 System Window

### 8.3.1 General

The *System Window* (fig. 8.3.1), displaying the yellow sports car, is the first entered on running NOVO-SOFT. From here you may configure the communications channels, receive data from an interfaced instrument, or enter the data analysis section of the software. It is also possible to enter the Help function directly, or

to browse through a guide to other Rhopoint™ products. Moving the pointer over the function buttons will display their designation on the help bar at the bottom of the Window.

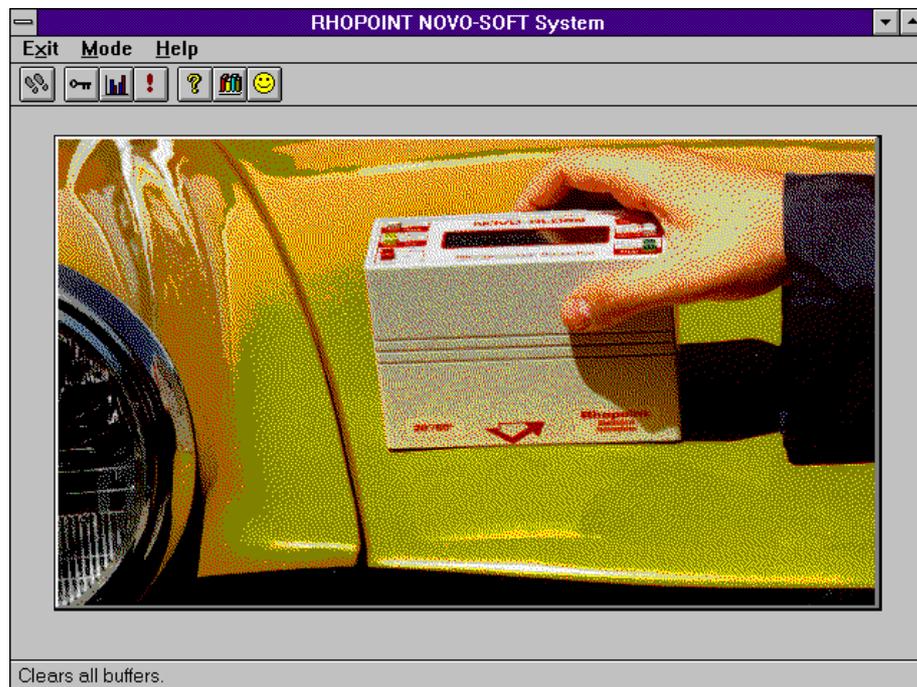


Fig. 8.3.1. The *System Window*.

### 8.3.2 *Down Loading Data*

Once the communications channel has been configured (see section 8.2), NOVO-SOFT is ready to receive data from within the *System Window*. Attempting to receive data from elsewhere in the NOVO-SOFT program will result in an error message, and any data sent will not be stored. However, this data is not lost as it is still stored in the instrument, and you should move to the *System Window* before attempting to down load again.

To send data from your instrument, make sure that it is powered up, and push its yellow 2<sup>nd</sup> function button, followed by the OUTPUT button. All data resident in the memory of your NOVO-PAC will be sent to your PC, and NOVO-SOFT will automatically collect it before prompting you for a filename under which to save it. Data is saved in a format recognised by NOVO-SOFT, which uses a \*.RES filename extension. If the Save \*.CSV files box in the *Configuration Window* has been checked, data is also saved in this format under the same filename, and may be easily imported by other applications, such as Lotus or Excel.

Please note that where NOVO-SOFT will deal only with the calculated hiding power results. The \*.CSV file will also contain the individual black and white readings, and their means. These can be viewed, if required, using a suitable spreadsheet program.

### 8.3.3 Flushing

The flush option in the Mode Menu (or ! button) is used to clear the communications channel if there has been a problem receiving data. Selecting this function will empty the serial buffers, and you should try downloading again.

## 8.4 File Management

When NOVO-SOFT is installed it automatically generates its own directory tree corresponding to the various angles at which measurements can be made using different instruments. On receiving data, the angle at which measurements were taken is automatically detected, and the appropriate sub-directory becomes the default location to save data. NOVO-PAC data has its own special sub-directory. Of course, you may save data where you wish, though if you do it is recommended that you include the measurement angle in the filename. If you have chosen to save data as \*.CSV files also, these will be saved in the same directory.

## 8.5 Results Window

### 8.5.1 General

The *Results Window* (fig. 8.5.1) is where numerical data is displayed and may be tagged or edited. Although there may be up to 999 data points in any set, only 72 may be displayed on the screen at any one time. Moving through the data is achieved using the buttons at the bottom of the Window. Page Up and Page Down will cycle through the data in blocks of 72 points. Home will return to the beginning of the data set, and End will transfer to the final page. At the top of the *Results Window* the following parameters are displayed:

- Angle - The angle at which measurements were taken (always 45°/0° for reflectometers such as NOVO-PAC).
- Total Samples - The number of data points currently in memory.
- Date and Time - When data was first downloaded to NOVO-SOFT.
- Filename - Remember that NOVO-SOFT uses the \*.RES file extension.
- Comment - First line of user defined statement pertaining to the data set. May only be edited from the *Statistics Window*.

Data may be saved or retrieved from the File menu, using the Save and Open options, in the normal Windows environment way.



The 'Tag all results' option may at first seem a little pointless, but is useful if you only wish to work with a small number or batch of readings within a large population. Simply tag all results, then untag the ones you wish to work with. Untagging all results returns them to their original status, enabling you to work with the entire population.

When tagging a block, you are asked to specify a range. The range specified is inclusive, and all results falling in this block will be tagged, or untagged, as specified, regardless of their original tagging status.

When single result is selected, the tagging status of the selected result is inverted, i.e. a tagged result will become untagged, and an untagged result will become tagged.

Invert tags will invert the tagging status of the entire data population.

#### 8.5.4 Exporting

Data may be exported in \*.CSV file format using the Export function. This is useful if you prefer to edit and analyse the data using your own software package, which will be able to recognise this file format. The file will be given the same name as that used for NOVO-SOFT data, but with the \*.CSV file extension. If you have checked the box in the *Configuration Window*, the original data will already be saved in \*.CSV form, but this will be overwritten if you have made any changes.

## 8.6 Statistics Window

### 8.6.1 General

The *Statistics Window* (fig. 8.6.1) displays a full analysis of all currently untagged files. Statistics available are maximum, minimum, mean, variance, standard deviation and coefficient of variation. The comment box displays text which may be edited by the user. As in the *Results Window*, the measuring angle is automatically displayed, as are the date and time at which the data was initially down loaded.

### 8.6.2 Comment

The comment statement is used to record any information particular to the results displayed, such as the conditions under which measurements were made, sample history, etc. It may be up to 10 lines long, and is edited by placing the cursor in the box. The comment can also be viewed one line at a time from the *Results Window*.

Fig. 8.6.1. The *Statistics* Window.

### 8.6.3 Statistics

The statistical parameters displayed are defined below. For this purpose the data are defined as values  $x_1, x_2, \dots, x_n$ , and  $x_i$  is any data point (c.f. section 3.5).

- Statistical sample population,  $n$  - the current number of untagged samples, on which the statistical analysis is based.
- Maximum - the highest untagged reading.
- Minimum - the lowest untagged reading.
- Mean,  $\bar{x}$  - The sum of all untagged readings divided by the total number,  $\bar{x} = \sum_{i=1}^{i=n} \frac{x_i}{n}$

- Variance,  $s^2$  - Sum of squared deviations of untagged readings from the mean,  $s^2 = \sum_{i=1}^{i=n} \frac{x_i^2 - \bar{x}^2}{(n-1)}$

- Standard deviation,  $s$  - Square root of the variance,  $s = \sum_{i=1}^{i=n} \left( \frac{x_i^2 - \bar{x}^2}{(n-1)} \right)^{1/2}$

- Coefficient of variation,  $c$  - Standard deviation divided by the mean, a measure of data scatter,  $c = \frac{s}{\bar{x}} = \sum_{i=1}^{i=n} \frac{n}{x_i} \left( \frac{x_i^2 - \bar{x}^2}{(n-1)} \right)^{1/2}$

## 8.7 Graph Window

### 8.7.1 General

The *Graph* Window (fig. 8.7.1) enables display of all results in a simple x-y plot of reading vs. hiding power. There are both 2D and 3D graph options, report printing facilities, and options for exporting graphics to other software.

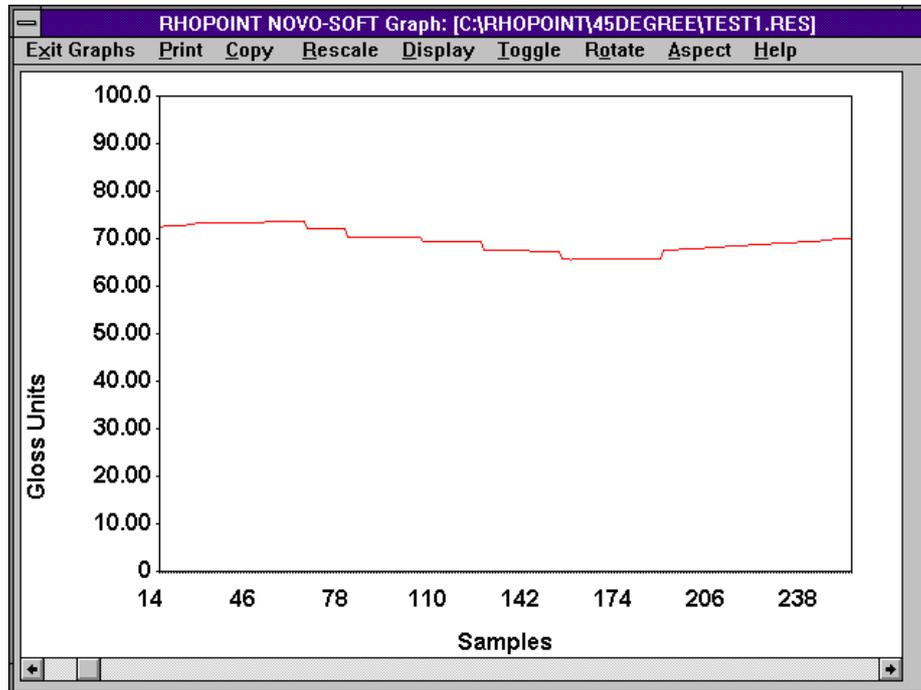


Fig. 8.7.1. The *Graph* Window.

### 8.7.2 2D Graphs

On entering the *Graph* Window you will always be in 2D display. Graphs are initially plotted by NOVO-SOFT on an automatic scale which accommodates all data. The y-axis can be redefined from the Rescale menu, which will prompt you for new maximum and minimum values accordingly. The Display menu allows you to move between 2D and 3D graph mode. An example of a NOVO-SOFT 2D graph is shown in fig. 8.7.1.

Each data point is represented on the graph by a square. As the graph starts to become crowded when dealing with large sample populations, the squares are not used when there are more than 50 data points, and a simple line graph appears. Only 330 data points may be shown on the screen at one time, and a scroll option appears when this number is exceeded.

### 8.7.3 3D Graphs

On entering the *Graph Window* you will always be in 2D display. The 3D graph mode is reached through the Display menu. The scale currently defined in 2D display is preserved when switching to 3D. Changes in 3D mode are likewise preserved on switching back. A large number of effects are possible in 3D graph mode, an example of which is shown in fig. 8.7.3.

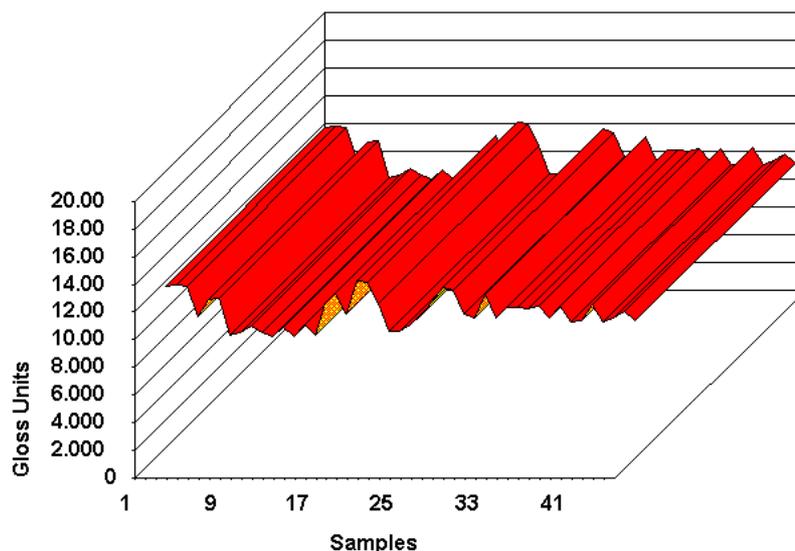


Fig. 8.7.3. An example of a typical 3D plot produced by NOVO-SOFT.

Rescaling 3D graphs is the same as for 2D graphs, but additional options affecting the appearance of the graph on the screen are given below:

- Toggle - When handling large volumes of data, 3D viewing may become a little confused. Toggle enables you to view the graph in more manageable portions.
- Rotate - Changes the horizontal angle at which you view the graph from.
- Aspect - Changes the vertical angle at which you view the graph from.

The effects of both Rotate and Aspect are best discovered by experimenting with the software.

### 8.7.4 Report Printing

The print option will produce a hardcopy report comprising the graph currently displayed, the comment and the statistical information. The text contained in the Document Header box in the *Configuration Window* (see section 8.2.3) appears at the top of the report.

### 8.7.5 Exporting Graphics

Copy will copy the graph as it currently appears (2D or 3D) to the clipboard. This is useful if you wish to produce your own graphical reports, and it may be saved as a \*.CLP file, or pasted directly into another application, as was done in producing this manual.

## 8.8 Statistical Graphs Window

### 8.8.1 General

The *Statistical Graphs* Window (fig. 8.8.1) can be reached from either the *Results* or *Statistics* Windows. Data is displayed both as a Bar Chart (Histogram) and as a Normal Distribution. The limits for both charts are preset, though future versions of NOVO-SOFT will allow greater versatility. The Copy option can be used to copy either graph to the clipboard, as outlined in section 8.7.5.

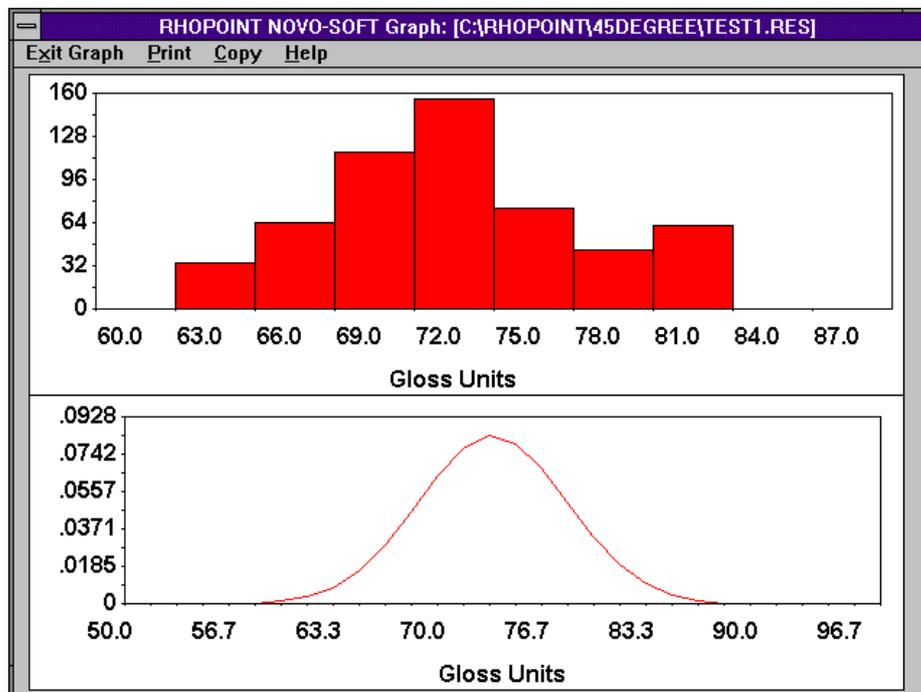


Fig. 8.8.1. The *Statistical Graphs* Window.

### 8.8.2 Histogram

The histogram produced by NOVO-SOFT (fig. 8.8.2) is always divided into ten bars. The values represented are all those from the value under the bar up to the value of the next. As the bars are equispaced, the final bar will cover the same size range as the others. The catchment area of each bar is automatically determined, as is the frequency scale on the y-axis. If your sample population contains any rogue data points which are greatly different in value from the mean (see section 8.6.3), it is better to tag (see section 8.5.3) these points to produce a useful histogram.

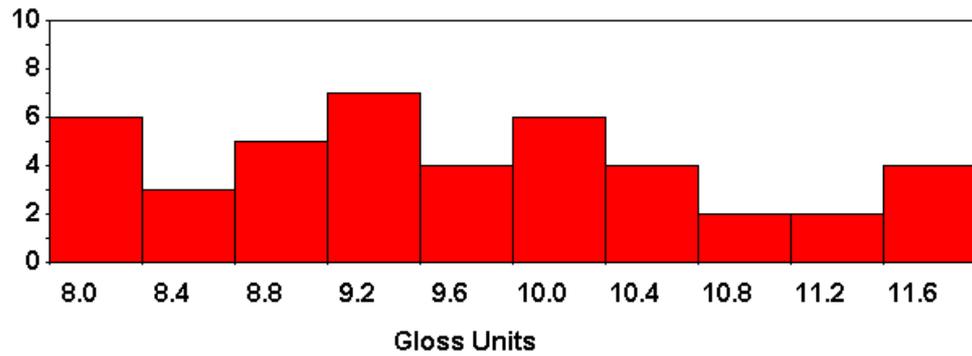


Fig. 8.8.2. A typical histogram produced by NOVO-SOFT.

### 8.8.3 Normal Distribution

The shape of a normal distribution (fig. 8.8.3) gives a measure of data scatter. The broader the peak, the more diverse the data. The scale on the  $y$ -axis is determined from the fact that, by definition, the area under a normal curve is always equal to unity. It will tend to be scaled to larger values when the data is less diverse.

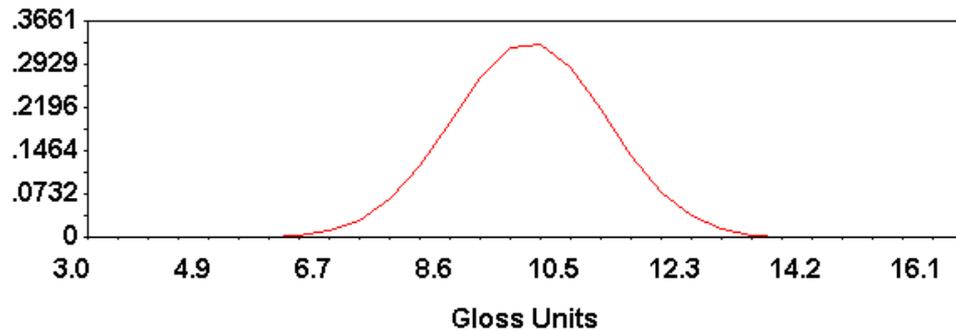


Fig. 8.8.3. A typical normal distribution graph produced by NOVO-SOFT.

## 9 OPTIMISING MEASUREMENTS

### 9.1 General Measurement Tips

It is important that the test area is free of dust, dirt, fingerprints, etc. as these will affect the reflectance.

Reflectometers integrate all the light going to the receptor, so if there is poor covering of the measuring aperture, and ambient light is able to get in, this will be detected and will result in anomalous high readings. When measuring translucent materials, such as plastic or glass, ambient transmitted light must be excluded by either working in a dark room, or by shielding with opaque cloth.

Reflectance is measured by integrating the light emitted vertically ( $0^\circ$ ) from a sample illuminated from the side at an angle of  $45^\circ$ . Since this is not the natural direction for reflected light to travel, reflectance measurement requires some degree of surface roughness to scatter light. A highly polished reflector will appear black to the instrument, and it is for this reason that a polished black tile is used as a zero calibration standard.

### 9.2 Care of Calibration Standards

Calibration standards should be kept scrupulously clean, and stored safely when not in use. The surface should never be touched or wiped with a cloth or solvents. Cleaning should only be carried out using dry, compressed air. Any marks on the surface, such as scratches, grease or dust, will invalidate the calibration value assigned to the standard. Standards should be calibrated every year by returning either directly to a recognised calibration house, such as BAM (Germany) or NRC (Canada), or to a dealer using standards traceable to these institutions, such as Rhopoint.

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NOVO-PAC is manufactured in the UK by:

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