

Lovibond PFX995/950 Series

OPERATORS INSTRUCTION MANUAL



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1. Introduction

Using the manual

The following typefaces and icons are used in this manual:

[] Characters between bold square brackets indicate a key on the keypad.

Examples:

[^] One of the keys directly below the display

[ZERO] Baseline measurement key

Italics A typeface in bold Italics indicates characters as shown on the display.

Examples:

Select menu item

Press any key to continue

Caution and safety signs



Caution Refer to manual



Warning Hot surface

An internal heater unit with a maximum temperature of 95°C may be present as a factory fitted option.

DO NOT TOUCH THE HEATER UNIT WHEN IT IS HOT

User responsibility

The responsible body should be made aware that if the instrument is used in any way not specified by the manufacturer, the protection provided by the equipment might be impaired.

The instrument is fitted with anti-tamper varnish in some critical areas. The instrument warranty is invalidated if these areas have been adjusted by anyone other than The Tintometer Ltd.

2. Instrument specification

Description

The Lovibond PFX995/950 instruments are high-precision, spectrophotometric colorimeters, which are designed for objective colour measurement of clear liquids or transparent solids. They are easy to use, automatic instruments, which overcome the subjectivity of visual methods. The menu system guides operators through the selection of operating parameters. Thereafter, measurements are initiated by just a single key press and take less than 25 seconds to complete. They are rugged colorimeters with fabricated steel housing, which are designed to function equally as a QC instrument within the laboratory or on 24-hour operation in a process control environment.

The Lovibond PFX995/950 operates as a stand-alone colorimeter containing a standardised light source and collimator, sample chamber with optional heater unit, light detector, monochromator and processor board. Wavelengths over the 420 - 710 nm range are isolated by the 16 narrow-bandpass interference filters, automatically selected in rapid sequence. The filters have peak transmissions on average of 20 nm apart but the measuring system is programmed to interpolate transmission figures for wavebands at 5 nm intervals, producing a total of 61 readings.

When printing results, the PFX995/950 will link with standard parallel printers.

Colour scales and optional items

The Lovibond PFX995/950 instruments are designed to meet the colour analysis requirements in the oils/chemicals and the mineral oils/petrochemicals industries. The PFX995 provides colour data according to a full range of established industry scales. The PFX950 is limited to the most commonly used scales. Measurements can also be displayed in terms of spectral data and CIE values. The user can easily customise both PFX995 instruments to display only those scales of interest.

The following selection of colour scales is included as standard on the PFX995/950 series:

Colour Scales	Scope	Range	995	995/P	950	950/P
AOCS-Tintometer	Special red and yellow version of the Lovibond RYBN scale used for oils, fats and derivatives	0 - 20 Red, 0 - 70 Yellow	•		•	
ASTM Colour	A wide range of petroleum products including lubricating oils, heating oils and diesel fuel oils	0.5 - 8 units		•		•
beta Carotene	Direct measurement of content in parts per million	0 - 1000 ppm	•		o	
Chlorophyll A & B	Direct measurement of content in parts per million	0 - 100 ppm	•		o	
FAC	Dark oils and fats including tallows and greases	1 - 45 (odd numbers)	•			
Gardner Colour	Oils & chemicals from pale yellow to red including lecithins, resins, drying oils & fatty acids	1 - 18 units	•		•	
Hess-Ives Units	Chemicals and surfactants		•			
Iodine	Oils and chemicals ranging from yellow to brown	0 - 500 units	•			
IP Units	Light coloured products such as refined undyed motor fuel, white spirit or kerosene	Water White (0.25) to Standard White (4.0)		•		
Klett Colour	Detergents and surfactants	0 - 1000 units	•			
Kreis Value	Quality testing of fats and oils for oxidative rancidity	Depends on concentration & path length	•			
Lovibond RYBN	Oils, fats, chemicals, resins and other transparent liquids in terms of Lovibond Red, Yellow, Blue and Neutral units	0 - 70 Red, Yellow; 0 - 40 Blue; 0 - 3.9 Neutral	•	•	•	
Pt-Co/Hazen/APHA Colour	Clear oils, chemicals and petrochemicals such as glycerine, plasticisers, solvents, carbon tetrachloride, and petroleum spirits.	0 - 500 mg Pt/l	•	•		•
Saybolt Colour	Light coloured petroleum products including aviation fuels, kerosine, white mineral oils, hydrocarbon solvents and petroleum waxes	-16 (darkest) to +30 (lightest)		•		•
AF960 Lovibond	Abridged red and yellow scale that was introduced on the AF960, an early electronic colorimeter. Use not recommended.	0 - 20 Red, 0 - 70 Yellow	•			
AF960 AOCS	Similar to AOCS-Tintometer Colour but modified for use on the AF960. Use not recommended.	0 - 20 Red, 0 - 70 Yellow	•			
CIE Values	X Y Z tristimulus values x y Y chromaticity co-ordinates L*c*h* colour space CIE L*a*b* colour space Hunter L a b colour space ΔE colour difference	Defined by spectrum locus	•	•	•	•
Spectral data (420 - 710 nm)	Transmittance (full spectrum + specified wavelengths)	0 - 100%	•	•	•	•
	Optical density	0 - 2.5	•	•		
Optional Items						
Integrated heater unit	A factory fitted option for maintaining samples such as fats and waxes in a liquid state.		o	o	o	o
Windows software for data capture on PC	Allows data sets to be automatically downloaded to a PC computer where they can be processed or stored. It also permits remote control of the instrument		•	•	o	o
Conformance filter sets	Sets of graded glass filters, representing a spread of colours from each of the main scales, are available for quick and simple calibration checks.		o	o	o	o

• included as standard o optional item

Accessories supplied

The accessories kit includes optical glass cells of the appropriate type and path length for each of the colour scales included (see below), a calibrated glass conformance filter and a spare lamp.

Order Code	Cell Designation	No. Supplied by Instrument Version							
		PFX995	PFX995 + heater	PFX995/P	PFX995/P + heater	PFX950	PFX950 + heater	PFX950/P	PFX950/P + heater
60 59 60	W600/OG/10 mm	1		1		1			
65 59 60	W600/B/10 mm		1		1		1		
60 60 10	W600/OG/33 mm			1				1	
65 60 10	W600/B/33 mm				1				1
60 60 30	W600/OG/100 mm	1		1				1	
65 60 30	W600/B/100 mm		1		1				1
60 60 80	W600/OG/1"	1		1		1			
65 60 80	W600/B/1"		1		1		1		
60 61 30	W600/OG/5¼"	1				1			
65 61 30	W600/B/5¼"		1				1		
60 61 50	W600/OG/6"			1					
65 61 50	W600/B/6"				1				

Additional and replacement optical glass cells with path lengths from 1/16" up to 6" are available to suit individual requirements.

Technical specification

Measurement principle:	16 all dielectric interference filters high pass bandwidth 20 nm \pm 0.5 nm
Spectral response:	420 - 710 nm
Filter wavelengths (nm):	420, 445, 460, 470, 490, 510, 530, 550, 570, 595, 605, 630, 645, 670, 685, 710
Repeatability:	
- chromaticity (x y):	\pm 0.0002
- transmittance:	\pm 0.25%
- Lovibond values (PFX995/950)	\pm 0.1
- Saybolt values (PFX995/950/P)	\pm 1
Measurement time:	Less than 25 seconds
Calibration:	Single key press, fully automated
Light source:	5 Volt, 10 Watt tungsten halogen lamp (lens ended)
Detection system:	Large area pin photodiode (blue enhanced)
Illuminant:	CIE Illuminant A, C, D65 (C only on PFX950)
Observer:	2°, 10° (2° only on PFX950)
Sample requirements:	Liquids or transparent solids in Lovibond precision optical glass cells
Interfaces:	Parallel (Centronics) printer port; serial RS 232 port (9 pin)
Input voltage:	Universal, via external power supply
Power consumption:	60 Watts (24 Volts)
Approvals:	CE
Display:	2 x 40 character back-lit LCD
Keypad:	21 key membrane keypad; washable polyester with audible feedback
Heater unit:	Factory fitted option, 95°C max
Environmental requirements:	
- temperature range	Operating +5°C - +40°C, Storage -20°C - +85°C
- relative humidity (non-condensing)	Operating 0% - 90%, Storage 0% - 85%
Instrument housing:	Fabricated sheet steel with tough textured paint finish
Dimensions:	Width 515 mm, depth 195 mm, height 170 mm
Instrument weight:	7.75 kg
Internal Fuse rating:	24 Volts, 3.15 Amps
Technical assistance:	~

3. Getting started

Unpacking

The Lovibond PFX995/950 weighs 7.75 kg. One person may easily lift it by placing their hands at either end of the instrument and lifting. Carefully remove the Lovibond PFX995/950 from its packing case. There are no internal packing pieces so that when all extraneous material has been removed the instrument is ready for use. The power supply, mains lead and accessories are all included in the packaging.

Installation

Place the instrument on a bench near a mains voltage supply which is free from excessive voltage fluctuations. The external power supply is auto voltage sensing, so no setting up is required for local voltages.



Do not operate the instrument in an atmosphere containing explosive gases.



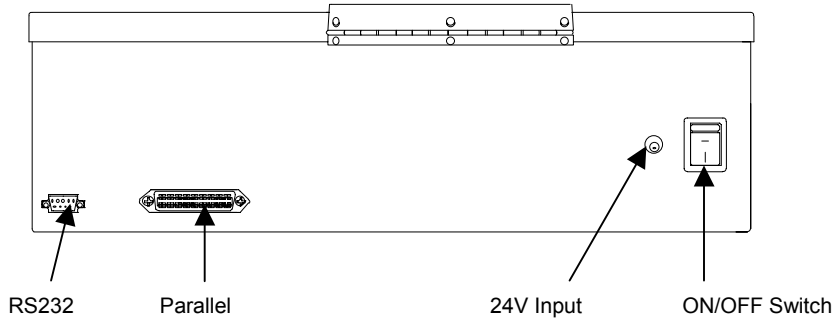
Plug in the mains lead and switch on. The green backlight of the display will indicate that the instrument is on.

If a new plug is fitted then it MUST be earthed.

If the instrument has been in a cold environment prior to setting up, allow the instrument to warm up to room temperature before switching on, and insure that all condensation has dissipated.

Always ensure that there is sufficient free space around the instrument to maintain a constant flow of air.

The remaining connection ports at the rear of the instrument are for use with various peripherals - printer and computer.



The printer outlet is a standard Centronics interface and will connect to any parallel printer. A standard parallel interface cable (Centronics - Centronics) can be purchased from most computer suppliers.

The computer outlet is a standard serial interface and will connect to an EN 6095 approved computer.

Using the keypad and display

The display has three functions: as the menu system for selecting the operating parameters; to show the chosen path length and to show measurement results.

Most of the time the display is used to show the measurement results. The menu system is brought into operation by pressing **[MENU]**. A descriptive message will appear on the top line of the display and up to four options along the bottom line. The required option is selected by pressing **[^]** directly below it. Depending on the parameter, the user may be presented with further messages and options.

4. Setting the operating parameters

Language for display

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Interfaces]**

Select menu item			
Date/Time	Language	Diagnostics	Printer
^	^	^	^

Select **[Language]**

Select language (English)			
>English		Next	Previous
^	^	^	^

Select **[Next]** or **[Previous]** to scroll through the list of languages available. When the required language is displayed, press the **[^]** directly below to select it.

Colour scale

The PFX995/950 includes a selection of the following colour scales (see **Instrument Specification**).

Colour Scale	Display	Range	Path length required
AOCS-Tintometer Colour	AOCS RY	0 - 20 Red, 0 - 70 Yellow	1", 5¼"
ASTM Colour	ASTM Color	0.5 - 8 units	33 mm
beta Carotene	Beta carotene	0 - 1000 ppm	10 mm
Chlorophyll A & B	Chlorophyll A B	0 - 100 ppm	10 mm
FAC Colour	FAC	1 - 45 (odd numbers)	10 mm
Gardner Colour	Gardner	1 - 18 units	10 mm
Hess-Ives Colour Units	Hess-Ives		10, 25, 50 mm

Colour Scale	Display	Range	Path length required
Iodine Colour	Iodine	0 - 500 units	10 mm
IP Units	IP	Water White (0.25) to Standard White (4.0)	6 inches
Klett Colour	Klett (42)	0 - 1000 units	40mm
Kreis Value	Kreis	Depends on concentration and path length	User selected
Lovibond Colour	Lovibond RYBN	0 - 70 Red, Yellow; 0 - 40 Blue; 0 - 3.9 Neutral	User selected
Pt-Co/Hazen/APHA Colour	Pt-Co	0 - 500 mg Pt/l	100 mm
Saybolt Colour	Saybolt	-16 (darkest) to +30 (lightest)	100 mm
AF960 Lovibond	AF960 Lovibond RY	0 - 20 Red, 0 - 70 Yellow	User selected
AF960 AOCS	AF960 AOCS RY	0 - 20 Red, 0 - 70 Yellow	User selected
CIE Values		Defined by spectrum locus	User selected
Spectral data			User selected

To select the required colour scale:

Press **[MENU]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Scale]**

Select colour scale to display			
>X Y Z		Next	Previous
^	^	^	^

Use **[Next]** or **[Previous]** to scroll through the list of colour scales available. When the required scale is shown, press the **[^]** key directly below the scale name to select it.

For colour scales where samples must be in a cell of set path length (see above table), if the path length is not as specified, then the following display is shown:

Path length incorrect for scale			
Continue	Set		
^	^		

Select **[Set]** to change the path length to that specified for the scale chosen. Or select **[Continue]** to use the current path length setting.

After selecting the colour scale, the display will revert to its home position. If the colour scale selected depends on the Observer and Illuminant, the display will show the following:

PFX995/950 V6.0 Path:10.00mm 2 Deg C			
X: ---.---	Y: ---.---	Z: ---.---	
^	^	^	^

Otherwise it will appear as.

PFX995/950 V6.0 Path:10.00mm			
Lovibond: --.-R	--.-Y	---.-B	---.-N
^	^	^	^

To store the measurement as a standard for DELTA E calculations, press the **[-]** key after the measurement has been completed.

To edit the colour scales menu to display only those scales of interest:

Press **[MENU]** whilst in the colour scale menu

Enable/Disable Scale View			
X Y Z		ON	OFF
^	^	^	^

Select ON to include the scale or OFF to exclude it. **NB:** You must complete this process for the full list of scales.

Path length

As summarised above, certain colour scales involve using cells of set path length; others involve operator choice (which typically depends on test specifications or the saturation of sample colour).

To select a path length, press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Params]**

Select menu item			
Path	Observer	Illuminant	
^	^	^	^

Select **[Path]**

Select path length			
>25.4 mm (1")		Next	Previous
^	^	^	^

Use **[Next]** or **[Previous]** to scroll through the list of available path lengths. When the required path length is shown, press the **[^]** key directly below the value to select it.

Although value of path length selected is not normally used in any of the calculations (with the exception of beta carotene and chlorophyll A & B), it is sent to the printer with the result.

Observer (PFX995 instruments only)

If the colour scale selected depends on the Observer and Illuminant, the settings display will be shown in the display.

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Params]**

Select Standard Observer			
Path	Observer	Illuminant	
^	^	^	^

Select **[Observer]**

Select path length			
2 Degree	10 Degree		
^	^	^	^

Select **[2 Degree]** for CIE 1931 standard observer or **[10 Degree]** for CIE 1964 standard observer.

Illuminant (PFX995 instruments only)

See section Colour scales about relevance of Illuminant to the measurement being made.

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Params]**

Select menu item			
Path	Observer	Illuminant	
^	^	^	^

Select **[Illuminant]**

Select Illuminant			
A	C	D65	
^	^	^	^

Select **[A]** for CIE Illuminant A, representative of a tungsten lamp at a colour temperature of 2856 K; **[C]** for CIE Illuminant C, representative of average daylight as from an overcast sky, with a colour temperature of 6774 K; **[D65]** for CIE illuminant D65, theoretical average daylight with a colour temperature of 6500 K.

User Specified Wavelength (for Transmittance Values)

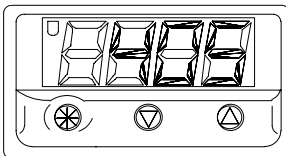
The instrument will display % transmittance at any specified wavelength over the range 420 - 700 nm. To enter the required wavelength, select **[User Wavelength]** in the colour scale menu and key in the wavelength. The display will revert back to its home position awaiting a measurement to be made. To change the specified wavelength press the key directly below **[Change]** on the screen and enter the new wavelength required.

Heater temperature (if fitted with heater unit)

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	Heater
^	^	^	ON

Select **[Heat ON]**



The heater controller unit is activated and powers the heater unit to the temperature set point that was last entered.

To input a new temperature set point.

- Press and hold the * button until the current temperature set point is shown on the controller display.
- Continue holding down the * button and use the up and down arrowed keys to obtain the desired temperature set point.

Note: The maximum temperature that can be entered is 95 deg C.

Printer options

The printer option determines whether results are printed when the **[PRINT]** key is pressed. The form-feed option tells the printer to eject the page after printing.

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Interfaces]**

Select menu item			
Date/Time	Language	Diagnostics	Printer
^	^	^	^

Select **[Printer]**

Printer:ON	Formfeed:ON		
Off	Type	Off	Apply
^	^	^	^

The printer option can be toggled on and off by selecting **[Printer:ON/OFF]**. The form-feed option can be toggled on and off by selecting **[Formfeed:ON/OFF]**.

To change the type of printer being used, select **[Type]**. The display will appear as below:

Select printer type			
Text	PCL		
^	^	^	^

Select **[Text]** for printers using standard Epson escape sequences. This option covers most Dot Matrix Printers. Select **[PCL]** for printers using Hewlett Packard PCL escape sequences. This option covers a number of Ink Jet and Laser Printers.

Date and time

Press **[Menu]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Interfaces]**

Select menu item			
Date/Time	Language	Diagnostics	Printer
^	^	^	^

Select **[Date/Time]**

Time: 14:10:44		Date: 29-04-1999	
Change	Apply		
^	^	^	^

If the date and time are correct select **[Apply]**. Otherwise, select **[Change]**, in which case the instrument will request entry of all time and date values in turn: **Enter Hours** (24 hour clock), **Enter Minutes**, **Enter Seconds**, **Enter Day**, **Enter Month**, **Enter Year**. After entering each value press **[.]** to move on.

The display will now show the date and time as entered:

Time: 14:10:44		Date: 29-04-1999	
Change	Apply		
^	^	^	^

If these values are correct select **[Apply]**. If not, repeat the above process.

Event and measurement log options

The event log sends a report to the printer summarising each change made within the menu system. The measurement log outputs results to the selected 'port', without having to press **[PRINT]**.

Press **[MENU]**

Select menu option			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Logging]**

Event:OFF		Meas:OFF	
ON	Port	ON	Apply
^	^	^	^

The event log option can be toggled on and off by selecting **[Event:ON/OFF]**. The measurement log option can be toggled on and off by selecting **[Meas:ON/OFF]**.

To choose the port for the measurement log select **[PORT]**.

Select port for measurement log			
Parallel	Serial	Both	
^	^	^	^

- Parallel: The measurement log is sent to the parallel port.
- Serial: The measurement log is sent to the serial port in ASCII format.
- Both: The measurement log is sent to the parallel port and then to the serial port.

User and sample ID options

When User ID:ON is selected, the user is asked to enter an ID number each time a measurement is made. This number can be up to 4 numeric characters long. When Sample ID:ON is selected, the user is asked to enter the ID number of the sample each time a measurement is made. This number can be up to 10 numeric characters long.

Press **[Menu]**

Select menu option			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Meas ID]**

User ID:ON		Sample ID:ON	
Off		Off	Apply
^	^	^	^

The User ID function can be toggled on and off by pressing the [^] directly below it. The Sample ID function can be toggled on and off by selecting the [^] directly below it.

When the required settings have been made, select **[Apply]** to exit from this menu.

Menu access

This function is designed so that the menu system can only be accessed by means of a password.

Press **[MENU]**

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select **[Options]**

Select menu item			
Meas ID	Params	Logging	Menu
^	^	^	^

Select **[Menu]**

Select menu access			
Full		Password	
^	^	^	^

Select **[Password]**. The following will appear:

Enter password			
			Backspace
^	^	^	^

Enter a password using the numeric keypad. **[Backspace]** can be used to delete mis-typed characters. Press the **[Enter password]** to enter the password.

To remove password protection, press **[Full]** under **Select menu access**.

Note: With the instrument set to menu access by means of a password, this password must be entered correctly otherwise menu access is denied. If the password is not recalled then contact Tintometer Ltd for special instructions.

5. Measuring a sample

When switched on, the operating parameters will be set to those selected when the instrument was last used. If appropriate, reselect the colour scale and path length required (see **Setting the operating parameters**).

Performing a baseline measurement [ZERO]

It is necessary to take a baseline measurement before carrying out sample measurements and at intervals during prolonged use. The baseline measurement calibrates the instrument on both dark and light values. **When performing a baseline measurement always ensure that the sample chamber is empty.**

The Lovibond PFX995/950 automatically takes a baseline measurement when it is first switched on. This measurement should be repeated at least every 4 hours by pressing the [ZERO] key.

Sample preparation

Where the measurement is according to a standard test method (see table), refer to the method for details of sample preparation. In general, samples should be clear and not turbid as suspended matter can cause scattering of the light beam, resulting in low transmittance values, which do not correspond with the sample colour.

Ensure that the end windows of the sample cell are clean and take care to handle cells only by the sides. Allow viscous samples time to settle, ensuring that air bubbles have dispersed and there is no movement in the sample. When samples are measured at elevated temperatures, the cell should also be heated to prevent the temperature gradient from distorting the light beam. Stirring the sample in the cell prior to measurement can help to create an even temperature throughout the sample.

Colour Scale	References
AOCS-Tintometer Colour	AOCS Cc 13b-45 the Wesson Method, AOCS Cc 8d-55, AOCS Cc 13j-97
ASTM Colour	ASTM D 6045, ASTM D 1500
Chlorophyll A & B	AOCS Cc 13d-55
FAC Colour	AOCS Cc 13a-43
Gardner Colour	ASTM D 1544, ASTM D 6166, AOCS Td 1a
IP Units	IP 17 Method B
Iodine Colour	DIN 6162
Klett Colour	AOCS Dd 5-92
Lovibond RYBN	AOCS Cc 13j-97, IP 17 Method A
Platinum-Cobalt/Hazen/APHA Colour	ASTM D 1209, AOCS Ea 9-65, AOCS Td 1b-64
Saybolt Colour	ASTM D 6045, ASTM 156

Taking a measurement

General instructions (see below for special instructions relating to specific colour scales)

After the baseline measurement is finished the instrument is ready for use. **Position the sample cell at the right hand end of the sample chamber.** Insert the sample against the right-hand end of the sample chamber. Close the sample chamber lid and press the [READ] key.

Special instructions relating to specific colour scales

- AOCS-Tintometer Colour** Unless working to a test method that specifies the path length, the cell used should relate to the colour of the sample. As a guideline, decrease the cell path length if the Red value is over 20 or if the Yellow value is greater than 50.
- beta Carotene** Dilute the sample using a ratio of 1 gram of sample in 100 millilitres of spectroscopic grade cyclohexane. Carry out the measurement in a 10 mm cell as per general instructions.
- Chlorophyll A & B** Ensure that the path length is set at 10 mm as this value is used in the calculations for chlorophyll A & B.
- FAC Colour** With melted fats, ensure that the sample is completely liquid. The sample should not be heated any higher than 10 degrees C above the melting point. Filter the sample if necessary.
- Lovibond Colour** Unless working to a test method that specifies the path length, the cell used should relate to the colour of the sample. As a guideline, decrease the cell path length if the Red value is over 20 or if the Yellow value is greater than 50.
- Pt-Co/Hazen/APHA** Due to low absorption of samples, a baseline measurement should be carried out once every 2 hours.
- Saybolt Colour** Due to low absorption of samples, a baseline measurement should be carried out once every 2 hours.

If the User ID option is enabled then the display will show:

User ID			Backspace
^	^	^	^

Enter the User ID code, and press [↵] to continue.

If the Sample ID option is enabled then the display will show:

Sample ID			Backspace
^	^	^	^

Enter the Sample ID code and press [↵] to continue.

The instrument will now take a measurement and the message **Performing measurement** appears on the display. The result will then appear on the display in the selected colour scale. If this is not the correct scale then reselect the scale required according to section 'Colour scale'. Once chosen, the instrument will calculate the result in the new scale.

To store the measurement as a standard for DELTA E calculations, press the **[Δ]** key after the measurement has been completed.

6. Recording results

Printing results

Set the appropriate printer options as described in 'Setting the operating parameters'. Connect the cable from a standard Centronics parallel printer to the PFX995/950 printer outlet. Press **[PRINT]** if results for one scale only are required.

Connecting to a computer

Only EN 60950 approved computers should be connected to the RS 232 port.

A software program that allows direct control of the Lovibond PFX995/950 from an IBM compatible computer can be purchased from the supplier. This software pack is supplied with an RS232 lead.

Communication by default takes place at these settings: 9600 Baud, 1 Stop Bit, 8 Data Bits, NO Parity

7. Regular Maintenance

Instrument cleaning

The Lovibond PFX995/950 instruments require minimal routine maintenance. However, any spillage on the instrument or in the sample chamber must be cleaned immediately and regular cleaning is recommended to ensure accurate and repeatable measurements:

Sample chamber	The sample chamber windows should be cleaned, if they become contaminated, by using a suitable lens cleaner or alcohol-based degreaser. Spillage can be removed from the chamber floor with a sponge and alcohol-based degreaser.
Keypad & display	These should be kept clean with an alcohol-based cleaner to aid reading of the display and the keys.
Instrument housing	Clean with detergent in warm water. Abrasive cleaners must not be used.

Care of glass cells

Cells should be cleaned immediately after use and examined for cleanliness and flaws before further use; otherwise sample transmittance values may be affected.

The cleaning process will depend on the nature of the sample. If necessary, immerse cells in a suitable strength, warm solution of detergent for several hours. Remove any remaining deposits on the cell faces by washing in 5% hydrochloric acid. When clean, rinse thoroughly in distilled water and, finally, in ethanol or acetone, before allowing to dry.

To remove stubborn staining, immerse the cell in freshly prepared chromic acid and leave overnight. The cell should then be rinsed and dried as above. Cells should not be allowed to dry out at any intermediate stage. Never attempt to clean the inside of cells with a cloth, as this may crack the windows. When cells are not in use, store them where they are protected from accidental damage.

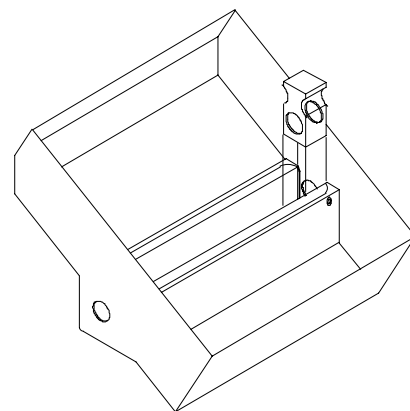
Checking measurements

A calibrated glass filter of known colour value is supplied for use as a checking measurement standard. Although not a substitute for regular calibration, which uses a range of filters, this standard provides the user with a method of demonstrating that the instrument is functioning correctly. The use of this standard will provide the user with confidence that the instrument is continuing to function within its specification.

The calibrated glass filter must be kept free from dirt and dust. The glass surfaces must never be touched.

To conduct a checking measurement using the calibrated glass filter, carry out the following actions:

- Ensure that the cell compartment is empty.
- Perform a baseline measurement **[ZERO]**
- Place the calibrated glass filter in the instrument as detailed in the diagram.
- Select the colour scale specified on the Certificate of Conformity, which is supplied with the filter.
- Press **[READ]**.



The measurement result will appear on the display. Check that the colour value falls within the tolerances specified on the Certificate of Conformity. It is recommended that the filter be returned to Tintometer Ltd annually for re-certification.

8. Warning Messages

Message	Action
Light level too low	Ensure that the sample chamber is empty and the sample chamber windows are clean
Light level too high	Check that the correct type lamp has been fitted, run the diagnostic routine then contact your Lovibond distributor
Lamp failure	Replace lamp
Stepper motor fault	Run diagnostic routine then contact your Lovibond distributor
Sample too dark	Use a shorter path length cell
E (on end of chlorophyll result)	This is an estimated result. Use a shorter path length cell.

9. Maintenance

Fault finding and diagnostics

The Lovibond PFX995/950 instruments are designed with only a single moving part and a range of thoroughly tested components that should give long, trouble-free service.

Users are notified of lamp failure by means of a message on the display.

LAMP FAILURE!! Switch off Instrument and replace lamp

Replace the lamp following the instruction given in 'Replacing spare parts'.

If the instrument gives erratic readings, check that the glass windows in the sample chamber and the sample cell are clean and that the sample shows no sign of turbidity. Carry out a checking measurement as detailed in 'Checking measurements'. If the Lovibond PFX995/950 continues to give erratic readings, run the diagnostic routine as follows:

Ensure that a printer is connected to the Lovibond PFX995/950 and that it is switched on.

Press [Menu]

Select menu item			
Scale	Options	Interfaces	
^	^	^	^

Select [Interfaces]

Select menu item			
Date/Time	Language	Diagnostics	Printer
^	^	^	^

Select [Diagnostics]

Start diagnostic test			
Press any key to continue (ESC to cancel)			
^	^	^	^

Follow the instructions as presented on the display. First of all the instrument will conduct a keypad test; press each key on the keypad as requested. The instrument will then perform a series of tests - stepper test, ADC test, lamp test, and filter test - that require no user intervention. The test results are then automatically output to the printer.

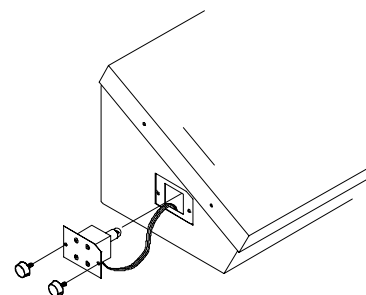
Please send or fax the test results to Tintometer Ltd or your Lovibond distributor for diagnosis.

Note: Always unplug the instrument from the power supply before opening the case.

Replacing spare parts

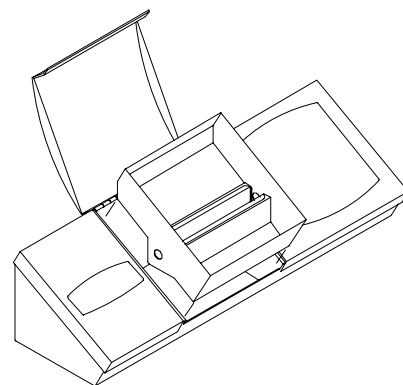
The lamp

The expected lamp life is 600 000 measurements before failure. When replacing the lamp, always unplug the instrument from the power supply. Undo the two thumbscrews and remove the lamp block. Unscrew the lamp from the block and replace with the new lamp. **Do not touch the glass lens on the lamp, as fingerprints will impair its performance.** Replace the lamp block and tighten the thumbscrews.



Sample chamber

In extreme cases the sample chamber can be removed for cleaning or replacement. To remove the sample chamber, open the sample chamber lid to its full extent. The sample chamber can then be lifted free from the instrument base as shown in the diagram. If a heater unit is fitted, then the left hand main lid requires removal in order to disconnect the heater power cable and thermocouple leads from the heater controller. This step is required before the sample chamber can be removed.



Keypad

- Disconnect the instrument from the power supply before removing the main covers.
- Slide the cover to the right until it releases and carefully lift clear of the instrument.
- Unplug the ribbon cables to the keypad and display.
- Carefully lift one edge of the keypad and peel away from the main lid.
- Remove any remaining adhesive on the lid using isopropanol alcohol.
- Peel the backing from the new keypad and thread the ribbon cable back through the aperture.
- Carefully align the keypad within the recess and press into place using a soft cloth.
- Replace all ribbon cables and lids in their original position.

10. Accessories and spares

Spares

The only component that requires periodic replacement is the lamp. None of the fuses used in the Lovibond PFX995/950 instruments are replaceable. The sample chamber and the keypad are also available as replacement items:

Code	Description
13 81 80	PFX995/950 Lamp 5V
13 92 00	PFX995/950 sample chamber
13 89 10	PFX995/950 membrane keypad

Instructions for replacement of spares are included under the section 'Replacing spare parts'

Accessories (PFX950)

Code	Description
13 89 00	Upgrade kit for Chlorophyll A & B and beta carotene
13 87 00	Windows software for data capture on PC

Lovibond glass cells

The Lovibond PFX995/950 instruments use the W600 series of glass cells. The choice of cell path length depends on the instrument version and the colour scale being used. For versions equipped with the heater unit and whenever hot samples are measured, it is recommended that borosilicate cells be used.

Path Length	W600/OG Series Fused Optical Glass		W600/B Series Fused Borosilicate Glass	
	Order Code	Type	Order Code	Type
2.5 mm	60 59 40	W600/OG/2.5		
5 mm	60 59 50	W600/OG/5		
10 mm	60 59 60	W600/OG/10	65 59 60	W600/B/10
15 mm	60 59 70	W600/OG/15		
20 mm	60 59 80	W600/OG/20		
25 mm	60 59 90	W600/OG/25	65 59 90	W600/B/25
33 mm	60 60 10	W600/OG/33	65 60 10	W600/B/33
40 mm	60 60 20	W600/OG/40	65 60 20	W600/B/40
50 mm	60 62 00	W600/OG/50		
100 mm	60 60 30	W600/OG/100	65 60 30	W600/B/100
$\frac{1}{16}$ "	60 60 40	W600/OG/ $\frac{1}{16}$ "	65 60 40	W600/B/ $\frac{1}{16}$ "
$\frac{1}{8}$ "	60 60 50	W600/OG/ $\frac{1}{8}$ "	65 60 50	W600/B/ $\frac{1}{8}$ "
$\frac{1}{4}$ "	60 60 60	W600/OG/ $\frac{1}{4}$ "	65 60 60	W600/B/ $\frac{1}{4}$ "
$\frac{1}{2}$ "	60 60 70	W600/OG/ $\frac{1}{2}$ "	65 60 70	W600/B/ $\frac{1}{2}$ "
1"	60 60 80	W600/OG/1"	65 60 80	W600/B/1"
2"	60 60 90	W600/OG/2"	65 60 90	W600/B/2"
3"	60 61 00	W600/OG/3"	65 61 00	W600/B/3"
4"	60 61 10	W600/OG/4"	65 61 10	W600/B/4"
5"	60 61 20	W600/OG/5"	65 61 20	W600/B/5"
5 $\frac{1}{4}$ "	60 61 30	W600/OG/5 $\frac{1}{4}$ "	65 61 30	W600/B/5 $\frac{1}{4}$ "
6"	60 61 50	W600/OG/6"	65 61 50	W600/B/6"

For further information on Lovibond cells, please ask your supplier.

Calibrated glass filter sets

For quick and simple calibration checks, sets of graded glass filters, representing a spread of values from the main colour scales included on the instruments, are available. Single filters for beta carotene and Chlorophyll A measurements are also available. The typical nominal values for each filter in the set are shown below; individual values may vary but these are always specified on the certificate of conformity supplied with the filters.

Code	Filter Set	No Filters	Nominal Colour Values				Measurement Tolerance
			Red	Yellow	Blue	Neutral	
13 95 90	Lovibond Red Yellow Neutral	10	0.1	0.5			$\pm 0.1R, \pm 0.1Y, \pm 0.1N$
			0.5	1.3		0.1	$\pm 0.1R, \pm 0.2Y, \pm 0.1N$
			1.0	2.6		0.1	$\pm 0.1R, \pm 0.2Y, \pm 0.1N$
			1.3	3.3		0.5	$\pm 0.1R, \pm 0.3Y, \pm 0.1N$
			2.0	5.7		0.1	$\pm 0.2R, \pm 0.3Y, \pm 0.1N$
			2.5	8.6		0.1	$\pm 0.2R, \pm 0.8Y, \pm 0.1N$
			3.2	15.0		0.1	$\pm 0.3R, \pm 1.0Y, \pm 0.2N$
			4.0	22.0		0.1	$\pm 0.4R, \pm 2.0Y, \pm 0.2N$
			5.0	34.0		0.1	$\pm 0.5R, \pm 3.0Y, \pm 0.2N$
13 96 10	Lovibond Red Yellow Neutral	5	0.1	0.5			$\pm 0.1R, \pm 0.1Y, \pm 0.1N$
			1.0	2.6		0.1	$\pm 0.1R, \pm 0.2Y, \pm 0.1N$
			2.0	5.7		0.1	$\pm 0.2R, \pm 0.5Y, \pm 0.1N$
			3.2	15.0		0.1	$\pm 0.3R, \pm 1.0Y, \pm 0.2N$
			5.0	34.0		0.1	$\pm 0.5R, \pm 3.0Y, \pm 0.2N$
13 96 20	Lovibond Red Yellow Blue	5	1.0		0.5		$\pm 0.1R, \pm 0.1B$
			1.2	4.3	1.2		$\pm 0.2R, \pm 0.4Y, \pm 0.2B$
			2.6	11.5	2.1		$\pm 0.2R, \pm 2.0Y, \pm 0.2B$
			3.4	15.9	2.9		$\pm 0.3R, \pm 2.0Y, \pm 0.3B$
			1.3		0.8		$\pm 0.1R, \pm 0.2B$
13 69 00	AOCS-Tintometer Colour	3	0.5	1.0			$\pm 0.2R, \pm 0.2Y$
			3.7	13.0			$\pm 0.2R, \pm 1.0Y$
			6.6	50.0			$\pm 0.2R, \pm 5.0Y$
Code	Filter Set	No Filters	Nominal Colour Values				Measurement Tolerance
13 95 10	ASTM Colour	3	0.5, 3.5, 5.0				± 0.1
13 95 60	Gardner Colour	4	2, 8, 12, 17				± 0.1
13 97 00	FAC	5	7, 13, 15, 29, 39				± 0.1
13 76 60	IP Units	4	0.75, 1.25, 2.0, 3.5				$\pm 0.25 (\pm 0.5 \text{ for } 3.5)$
13 95 70	Platinum-Cobalt/Hazen/APHA	5	5, 20, 50, 100, 300				$\pm 2, \pm 2, \pm 3, \pm 4, \pm 10$
13 95 80	Saybolt Colour	5	-8, 0, +10, +18, +25				± 1
13 95 20	Beta carotene	1	45 ppm (at 10 mm path length)				$\pm 2\text{ppm}$
13 95 30	Chlorophyll A	1	0.19 ppm (at 10 mm path length)				$\pm 0.1\text{ppm}$

If necessary, single calibrated glass filters can be supplied; however, we recommend that complete sets of filters be purchased as the user can then check more than one point across the colour scale.

11. Factors Influencing Inter-Instrument Differences in Lovibond Colour Measurements

A common query relates to inconsistencies in the Lovibond Colour values obtained for an individual sample when using different instruments (for example, an automatic Tintometer such as the PFX995 and a visual instrument such as the Model E or F, or two different visual instruments). There are many reasons why such inconsistencies can arise; we have attempted to provide below a detailed list of the main factors, which influence inter-instrument differences, which should help you to resolve these queries. These factors fall into four main categories:

- Poor maintenance of a visual instrument
- Comparison of different instrument versions
- Incorrect use of visual instruments
- Limitations and errors associated with automatic measurement

Poor Maintenance of a Visual Instrument

The Lovibond Tintometer is a precision optical instrument and any discoloration of the white surfaces or dirt on the various optical components will affect the nature and balance of illumination within the instrument and result in false readings. As a result, for consistency and accuracy in colour measurement, the Tintometer should be kept as clean as possible and the whiteness of the sample chamber and the white reference maintained. Particular attention should be given to the following areas:

- **Dirt and grease on the glass filters and racks.** These can be cleaned with a soft cloth or washed gently with warm soapy water.
- **Dust and dirt which gathers in the optical viewing system and can settle on the lens and correction filter.** If dirty the optical viewing system can be dismantled and the components cleaned with a suitable soft cloth. Be sure to reassemble correctly (see manual).
- **Discoloration of the white reference.** Periodic replacement is necessary to maintain accuracy of measurement.
- **Light source discoloration.** In the Tintometer Model E and earlier models the tungsten bulbs will discolour with age so that the instrument's illumination is no longer standardised. As a result, the bulbs should be changed periodically.

- **Discoloration and spillage in the white light sample chamber.** It is important to remove any spillage immediately and clean the chamber area.
- **Dirt on the bulb diffuser plates reducing the amount of illumination to the sample.** These should be cleaned or replaced if dirty.

Comparison of Different Instrument Versions

Users often assume that there is only one version of the Model E and Model F Tintometers; in fact, these instruments have for some time been supplied in slightly varying formats to meet the requirements of national and international standard test methods which specify use of the Lovibond Tintometer. In particular, BS 684 Section 1.14, ISO/FDIS 15305 and AOCS Cc 13e-92, all standard test methods for the determination of Lovibond colour of animal and vegetable fats and oils, specify the use of the Model F (BS 684) (previously the Model E version AF905). These instruments include racks, which are fitted with colourless glass compensating slides in the sample field and a black sheath to prevent light entering the sides of the sample cell; they will give different readings to the standard Tintometer versions and to automatic Lovibond instruments.

Incorrect Use of Visual Instruments

- **Incorrect use of neutral racks.** The two neutral racks included with the Tintometer should be used to dull the sample so that the brightness in sample field and the brightness in the comparison field are comparable. Many visual instrument users fail to use neutral glasses; the result will be a lighter colour measurement to compensate for brightness in the sample field.
- **Inappropriate choice of path length.** The optical path length of the cell used should be related to the colour intensity of the sample. As a guide, it is advisable to restrict the colour intensity of the sample to less than a total of 30 - 40 Lovibond units. Using a shorter path length cell can reduce colour intensity.
- **Subjectivity of visual measurement.** Visual measurements are influenced by the discriminatory power of operators, their interpretation of a colour match and physiological factors such as age, eye fatigue and colour vision.

Limitations and Errors Associated with Automatic Measurement

- **Use with samples which are turbid or crystalline.** This will affect colour measurement since turbidity prevents light being transmitted through the sample.
- **Lack of care in sample cell cleaning and sample preparation.** Any contamination, uneven mixing or a temperature gradient might distort the light transmitted through the sample and affect measurements.

LOVIBOND PFX995/950 CALIBRATION PROCEDURE

Introduction

By following these instructions and using the calibration result sheet provided, the user can carry out regular calibration of the PFX995/950 instrument.

This procedure verifies that the PFX995/950 is performing within its stated accuracy and precision. The instrument has a stable measurement system that has no internal adjustments. The accuracy of the instrument is however dependent on the cleanliness of the cell compartment and its optical windows and the condition of the tungsten halogen lamp. Both of these should be maintained as described in the maintenance section of this manual. The instrument must always be operated within the environmental conditions stated in the Technical Specification.

Calibration Interval

The calibration interval is dependent upon the environment in which the instrument is operated. It is recommended that calibrations are initially performed every three months. This interval can be extended as confidence grows in the stability of the instrument in the particular operating environment.

Recording Results

The calibration results for the instrument may be recorded on the attached calibration result sheet.

Equipment Required

- 1) Certified conformance filter set.
- 2) Thermometer.

Test Procedure

Switch on the instrument.

Select the colour scale as indicated on the Certificate of Conformity supplied with the conformance filter set.

Place one of the filters in the instrument and press the read button.

Ensure that the displayed result is within the stated tolerance.

Repeat for the remaining filters in the set.

Complete the calibration test result sheet.

Equipment Labelling

Place a new calibration label on the instrument with the following details:

- 1) Calibration date
- 2) Next calibration due date
- 3) Signature

Calibration Results

The calibration results sheet should be maintained as a record of the instrument's continued performance.

It is recommended that calibration results are maintained for a minimum of five years.

The conformance filter set should be returned to Tintometer Ltd annually for re-certification.

**LOVIBOND PFX995/950
CALIBRATION TEST RESULT SHEET**

Instrument serial number: _____

Conformance filter serial numbers: _____

Instrument Recorded Results:

Conformance filters certified values: _____

Instrument measurement tolerances as identified on the certificate of conformity: _____

Instrument indicated result (prior to maintenance): _____

Instrument indicated result (post maintenance): _____

Details of maintenance carried out:

Ambient temperature: _____

Performance status (pass/fail): _____

Tested by (print name): _____

Signature: _____

Date _____