xylem

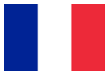
INSTRUCTIONS
B+S CODE: 44-571 / VERSION 5A

Abbe 5 Refractometer

INSTRUCTIONS FOR GENERAL USE

Bellingham + Stanley

a xylem brand



Mode d’emploi
Pour afficher et télécharger ce manuel d’instructions dans une autre langue, visitez notre site Web et utilisez la recherche par motclé «Abbé 5», puis sélectionnez «Manuel» dans l’onglet Tous les documents.

Anleitung
Um diese Bedienungsanleitung in einer anderen Sprache anzuzeigen und herunterzuladen, besuchen Sie bitte unsere Website und verwenden Sie die Stichwortsuche „Abbe 5“ und wählen Sie „Manual” auf der Registerkarte All Documents.

Instrucciones
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Instructions
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www.xylemanalytics.com/en/customer-support/downloads

DECLARATION OF CONFORMITY

According to BS EN ISO/IEC 17050-1

Manufacturer's Name:	Bellingham & Stanley Ltd.
Manufacturer's Address:	Xylem, Longfield Road, Tunbridge Wells, Kent , TN2 3EY United Kingdom

declares that the product:

Product Name	Abbe 5 Refractometer

conforms to the following Product Specifications:

Safety	BS EN 60950-1:11/2006
EMC	EN 55024 : 10/2003 EN 55020 : 11/2005
Supplementary	This product is in conformity with the requirements of the EMC Directive 2004/108/EC and Low Voltage Directive 2006/95/EC.

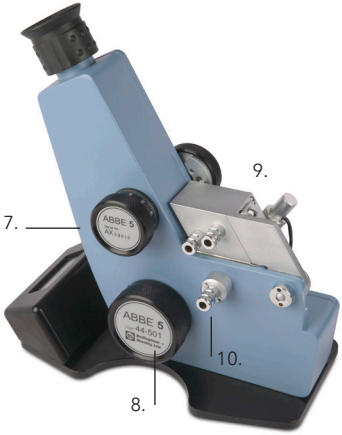
CE

RoHS Compliant

This symbol is an internationally agreed indicator that the product bearing it should not be disposed of as general waste or garbage which might end up in landfill sites, but should instead be sent for special processing and/or recycling in those countries where appropriate legislation and facilities are in place.

This symbol indicates a caution or warning, please refer to the manual.

Abbe 5 part list



1. Eyepiece
2. Light source (optional)
3. Locking knob
4. Light collector
5. Calibration screw
6. Temperature display
7. Dispersion knob
8. Control knob
9. Upper prism
10. Temperature control ports

Contents list

Abbe 5 Refractometer complete with accessories:

1	Refractometer	--
1	Operating Instructions	44-571
1	Calibration test piece	44-595
1	Screwdriver	44-596
1	Bottle of monobromonaphthalene	10-43
1	Pipette	80-050
1	Battery – LR44 alkaline 1.5V button cell	

Fitting the battery

To fit a battery into the temperature display module, remove the 2 screws securing the module to the base plate, remove the round battery retaining cap and insert the battery ensuring the polarity is correct.

Once the battery is installed, the temperature will be displayed continuously.

Positioning the system

Place the instrument on a flat and stable bench which is:

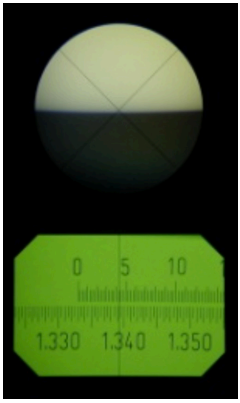
- dry and indoors.
- away from draughty or hot equipment like fans or heaters.
- out of direct sunlight.
- away from potential sources of interference, such as RFI generating equipment.
- For extra stability two fixing holes are located at the front of the instrument base plate to facilitate permanent fixture to a workbench.

Taking a reading

The sample is placed on the prism and is illuminated by aligning the chrome-plated reflector with a suitable light source (sunlight or desk lamp etc.). Adjustment of achromatising prisms by rotating the dispersion knob provides a means of ensuring the reading is obtained at the correct wavelength (589nm for standard measurement). The borderline may then be observed through the eyepiece and the reading in either Refractive Index or Brix scales may be taken from the integral scale.

1. Look through the eyepiece and rotate the focussing ring to focus the scale and borderline display.
2. Adjust the dispersion knob to remove colour (blue in one direction and red in the other) until you create a sharp borderline.
3. Rotate the control knob to align the borderline (the edge between the light and dark regions) with the centre of the crosswires.
4. Rotate the light collector for best scale illumination.

Record the reading value from either the refractive index or Brix scales and the temperature. The refractive index of a liquid varies with temperature so the instrument must be controlled at a fixed temperature by circulating water or the reading must be corrected for the actual measurement temperature.



The borderline

Configure the mode

The instrument may be configured to work in either the traditional 'transmission mode' or, for non-homogenous or opaque samples, 'reflection mode'.

A measure of principal dispersion for samples such as hydrocarbons or solid materials such as glass, contact lenses and fibre optics can be determined by a straightforward method using the normal white light source and taking readings from the dispersion knob.

Temperature

Waterbath connections provide prism temperature control, with the prism temperature being monitored electronically and visible on the digital display.

With good temperature control and precise calibration, readings in RI may be obtained to 4 decimal places or in °Brix to 1 decimal place.

Fitting the optional light source

First remove the 2 screws fitted to the top of the instrument's base plate on the left hand side. Align the light source mounting points over the 2 tapped holes, ensuring that the DC power socket is facing away from the temperature module. Replace the 2 screws, and plug the light source into the supplied mains power supply.

The light source control knob allows the lamp to be switched off when not in use and adjusted to achieve the ideal sample illumination.

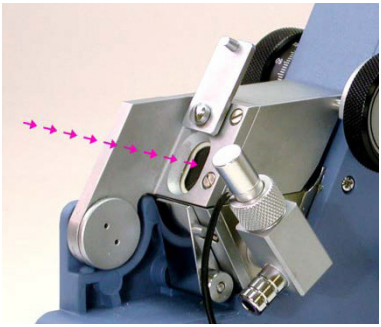
Measurements

Liquid samples

1. Turn the locking knob and raise the upper prism.
2. Place a few drops of sample on the lower prism and close the upper prism, securing it with the locking knob. Sample should evenly cover the whole of the prism surface without any air-bubbles.

Transparent samples - transmission mode

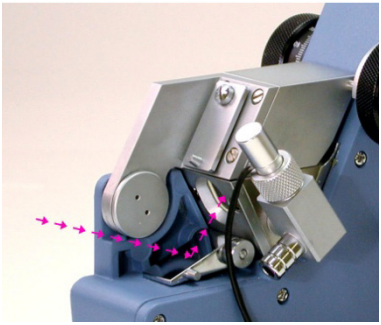
1. Transmitted mode of illumination is most commonly used for homogenous liquid samples.
2. Open the shutter on the upper prism and raise the mirror shutter on the lower prism. This will allow light to pass through the upper prism and the sample.



Transmission Mode

Opaque samples - reflection mode

1. Reflected mode of operation is more suited to opaque samples, however, the borderline is not as visible as transmitted mode.
2. Close the shutter on the upper prism and lower the mirror shutter on the lower prism. This will allow light to be reflected off of the underside of the sample.



Reflection Mode

Cleaning the prisms

Samples should be removed from the prism surfaces as soon as practical after measurement. Leaving sample between the prisms for long periods, and allowing it to dry, can cause the two prisms to stick together.

The sample should be removed from both prisms using a suitable solvent; distilled water or alcohol, depending upon whether the sample is water or oil based, and cleaned with tissue. The prisms should then be finally washed with distilled water or alcohol and dried with clean tissue.

Note: When cleaning the prisms, please remember that excessive rubbing with abrasive tissues could scratch the prism surfaces. This would reduce the quality of the borderline and also cause sample contamination. B+S do not recommend the use of aggressive solvents such as acetone – always use alcohols or other non-aggressive solvents.

Cleaning the eyepiece

The eyepiece lens should be regularly cleaned with a dry cloth or tissue.

Do not use water or any solvent to clean the eyepiece lens. This can enter the focussing assembly and cause clouding of the viewing area.

Checking the instrument with the test piece

Apply two small drops of monobromonaphthalene contact liquid (supplied with the instrument, code no. 10-43) to the centre of the measurement prism, using a small wooden or plastic stick. The test piece should be placed polished side down onto the prism on top of the contact liquid. Take care when applying the test piece not to scratch the prism. The contact liquid should spread out under the test piece and cover the whole of the interface between the test piece and the prism.

It is important to use the correct amount of contact liquid; there should be just sufficient to cover the interface but should not spread beyond the test piece edges. The correct amount can only be found with experience.

To check the test piece is applied correctly, see that it does not rock. If it does, remove the test piece and clean off the contact liquid; then re-apply as above.

To remove a test piece from the prism, apply an alcohol-based solvent liberally around the test piece and allow it to "float" off of the prism surface with the minimum of sliding.

The actual refractive index of each test piece is engraved on its upper surface.

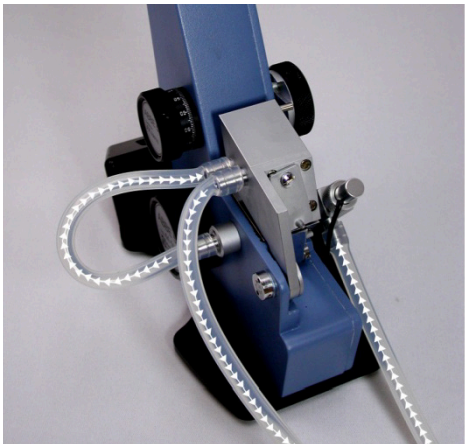
The refractive index can be read from the scale and compared with the test piece value.

Adjusting the instrument calibration

If the reading of the test piece is not correct, the instrument calibration can be easily adjusted.

Ensure that the borderline is accurately aligned with the centre of the crosswires.

Gently adjust the calibration screw using the screwdriver supplied so that the correct reading is shown on the scale.



Temperature control from a circulator

Refractive index change with temperature

The refractive index of all samples will vary with temperature. If it is required to know the refractive index of the sample at 20°C, then either the instrument must be controlled at 20°C, as described below, or a correction value for the sample must be added to the scale reading.

The correction value will vary considerably with different sample types. Glass samples have a low temperature coefficient, water based products are higher and oils and chemicals generally greatest. Typical (and very approximate) values are:

Sample	Temperature coefficient: Change in index/ °C
Glass	+0.00001
Water	-0.00010 (-0.07°Brix)
50% sucrose sample (50°Brix)	-0.00017 (-0.08°Brix)
Edible oil	-0.00040

Temperature control from a circulator

Both the fixed and hinged prism boxes are fitted with nozzles for water circulation in order to maintain the prisms and sample at known temperatures.

By controlling the instrument to a constant temperature, the time necessary for the instrument to stabilise after applying a sample to the prism will be minimised and measurement conditions will be optimised for high accuracy work.

If it is practical to control the instrument temperature to 20°C, correcting the readings for the sample temperature coefficient will not be required.

It is recommended that the two boxes are connected in series as follows.

Incoming water should be fed into the right hand side of the main body, when viewed from the front. The water will exit through the left side of the main body. A short length of tubing should be connected to this nozzle and connected to the rear nozzle of the upper prism box. Tubing on the front nozzle on the upper prism box will return the water back to the circulator. It is advisable to secure the tubing to the nozzles with hose clips.

Consult SDS information when using chemicals.

Temperature correction values for sucrose samples

Correction values for sucrose solutions measured on the Brix (% Sucrose) scale are shown in the table below. The correction values should be added to the scale reading.

Temperature °Celsius	Scale reading °Brix																	
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
15	-0.29	-0.30	-0.32	-0.33	-0.34	-0.35	-0.36	-0.37	-0.37	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.37	-0.37
16	-0.24	-0.25	-0.26	-0.27	-0.28	-0.28	-0.29	-0.30	-0.30	-0.30	-0.31	-0.31	-0.31	-0.31	-0.31	-0.30	-0.30	-0.30
17	-0.18	-0.19	-0.20	-0.20	-0.21	-0.21	-0.22	-0.22	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.22
18	-0.12	-0.13	-0.13	-0.14	-0.14	-0.14	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
19	-0.06	-0.06	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.07
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07
22	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15
23	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.22
24	0.27	0.28	0.29	0.29	0.30	0.30	0.31	0.31	0.31	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.30	0.30
25	0.34	0.35	0.36	0.37	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.40	0.40	0.39	0.39	0.38	0.38	0.37
26	0.42	0.43	0.44	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.48	0.48	0.48	0.47	0.47	0.46	0.46	0.45
27	0.50	0.51	0.52	0.53	0.54	0.55	0.55	0.56	0.56	0.56	0.56	0.56	0.56	0.55	0.55	0.54	0.53	0.52
28	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.64	0.64	0.65	0.65	0.64	0.64	0.63	0.63	0.62	0.61	0.60
29	0.66	0.67	0.68	0.70	0.71	0.71	0.72	0.73	0.73	0.73	0.73	0.73	0.72	0.72	0.71	0.70	0.69	0.67
30	0.74	0.76	0.77	0.78	0.79	0.80	0.81	0.81	0.82	0.82	0.81	0.81	0.80	0.80	0.79	0.78	0.76	0.75
31	0.83	0.84	0.85	0.87	0.88	0.89	0.89	0.90	0.90	0.90	0.90	0.89	0.89	0.88	0.87	0.86	0.84	0.82
32	0.92	0.93	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.98	0.97	0.96	0.95	0.93	0.92	0.90
33	1.01	1.02	1.03	1.05	1.06	1.07	1.07	1.08	1.08	1.08	1.07	1.07	1.06	1.04	1.03	1.01	1.00	0.98
34	1.10	1.11	1.13	1.14	1.15	1.16	1.16	1.17	1.17	1.16	1.16	1.15	1.14	1.13	1.11	1.09	1.07	1.05
35	1.19	1.21	1.22	1.23	1.24	1.25	1.25	1.26	1.26	1.25	1.25	1.24	1.23	1.21	1.19	1.17	1.15	1.13
36	1.29	1.30	1.31	1.33	1.34	1.34	1.35	1.35	1.35	1.34	1.34	1.33	1.31	1.29	1.28	1.25	1.23	1.20
37	1.39	1.40	1.41	1.42	1.43	1.44	1.44	1.44	1.44	1.43	1.43	1.41	1.40	1.38	1.36	1.33	1.31	1.28
38	1.49	1.50	1.51	1.52	1.53	1.53	1.54	1.54	1.53	1.53	1.52	1.50	1.48	1.46	1.44	1.42	1.39	1.36
39	1.59	1.60	1.61	1.62	1.63	1.63	1.63	1.63	1.63	1.62	1.61	1.59	1.57	1.55	1.52	1.50	1.47	1.43
40	1.69	1.70	1.71	1.72	1.73	1.73	1.73	1.73	1.72	1.71	1.70	1.68	1.66	1.63	1.61	1.58	1.54	1.51

Example:

An Abbe 5 gives a reading of 35.4° Brix at a temperature of 32° C

Scale reading of instrument = 35.4 Correction = 0.99
Equivalent value at 20°C = 36.39 which should be realistically rounded to 36.4

Dispersion measurements

The principal dispersion n_F-n_C of a sample or glass plate can be determined by a simple measurement procedure and calculation.

Principal dispersion n_F-n_C = A + B x M

where A, B & M are taken from the tables below.
Procedure:

1. Check, and if necessary adjust, the instrument calibration using a known standard as described above.
2. Apply the test sample and take a reading as normal, i.e. adjust the control knob to align the borderline with the centre of the crosswires and the dispersion knob to remove colour & create a sharp borderline.
3. Note the refractive index reading from the scale (nD).
4. Note the reading of the dispersion knob scale as accurately as possible (0 to 60).
5. Rotate the dispersion knob through 180° and carefully adjust to remove colour from the borderline.
6. Note the reading of the dispersion knob scale as accurately as possible.
7. Rotate the dispersion knob back to the first position, carefully adjust to remove colour and again note the reading of the dispersion knob.
8. Repeat steps 5-7 until you have recorded 5 readings for each half of the dispersion knob.
9. Calculate the average value of the 10 readings (Z).
10. From Table 1 (see next page), determine values of A & B for the reading nD (step 3), interpolating between adjacent values.
11. From Table 2 (see next page), determine the value of M.
    for the average dispersion knob reading Z (step 9), interpolating between adjacent values (note polarity).
12. Calculate n_F-n_C =A+BxM.

Example

The following readings were taken of a silica test plate placed on the prism with contact fluid:

Refractive index reading from the scale (nD) = 1.4584

Dispersion knob readings

Clockwise Measurements	Anti-clockwise Measurements	Average of all measurements (Z)
42.0	42.2	42.17
42.1	42.2	
42.0	42.1	
42.0	42.5	
42.1	42.5	

Values for A, B and M were calculated from the Tables 1 & 2 using n_D and Z. A = 0.024354 B = 0.029572 M = -0.59497.

n_F-n_C = A + B x M = 0.024354 + (0.029572 x –0.59497) = 0.00676 Published value[1] of n_F-n_C for silica = 0.00675.

1. Taken from "Tables of Physical and Chemical Constants 16th Edition, Kaye and Laby" .

Dispersion conversion tables

Table 1				
n_D	A	A diff	B	B diff
1.300	0.02494	-0.00006	0.03340	-0.00013
1.310	0.02488	-0.00005	0.03327	-0.00016
1.320	0.02483	-0.00005	0.03311	-0.00016
1.330	0.02478	-0.00005	0.03295	-0.00019
1.340	0.02473	-0.00004	0.03276	-0.00020
1.350	0.02469	-0.00005	0.03256	-0.00021
1.360	0.02464	-0.00004	0.03235	-0.00023
1.370	0.02460	-0.00004	0.03212	-0.00025
1.380	0.02456	-0.00004	0.03187	-0.00026
1.390	0.02452	-0.00004	0.03161	-0.00028
1.400	0.02448	-0.00003	0.03133	-0.00029
1.410	0.02445	-0.00004	0.03104	-0.00031
1.420	0.02441	-0.00003	0.03073	-0.00033
1.430	0.02438	-0.00003	0.03040	-0.00034
1.440	0.02435	-0.00003	0.03006	-0.00036
1.450	0.02432	-0.00003	0.02970	-0.00038
1.460	0.02429	-0.00002	0.02932	0.00040
1.470	0.02427	-0.00002	0.02892	-0.00041
1.480	0.02425	-0.00002	0.02851	-0.00043
1.490	0.02423	-0.00002	0.02808	-0.00046
1.500	0.02421	-0.00001	0.02762	-0.00047
1.510	0.02420	-0.00001	0.02715	-0.00050
1.520	0.02419	-0.00001	0.02665	-0.00051
1.530	0.02418	-0.00001	0.02614	-0.00054
1.540	0.02417	0.00000	0.02560	-0.00056
1.550	0.02417	0.00000	0.02504	-0.00059
1.560	0.02417	0.00001	0.02445	-0.00061
1.570	0.02418	0.00001	0.02384	-0.00064
1.580	0.02419	0.00002	0.02320	-0.00067
1.590	0.02421	0.00002	0.02253	-0.00070
1.600	0.02423	0.00002	0.02183	-0.00073
1.610	0.02425	0.00003	0.02110	-0.00077
1.620	0.02428	0.00004	0.02033	-0.00080
1.630	0.02432	0.00005	0.01953	-0.00085
1.640	0.02437	0.00005	0.01868	-0.00089
1.650	0.02442	0.00006	0.01779	-0.00095
1.660	0.02448	0.00008	0.01684	-0.00100
1.670	0.02456	0.00009	0.01584	-0.00107
1.680	0.02465	0.00010	0.01477	-0.00114
1.690	0.02475	0.00013	0.01363	-0.00124
1.700	0.02488		0.01239	

Table 2		
Z	M	M diff
0	1.000	0.001
1	0.999	0.004
2	0.995	0.007
3	0.988	0.010
4	0.978	0.012
5	0.966	0.015
6	0.951	0.017
7	0.934	0.020
8	0.914	0.023
9	0.891	0.025
10	0.866	0.027
11	0.839	0.030
12	0.809	0.032
13	0.777	0.034
14	0.743	0.036
15	0.707	0.038
16	0.669	0.040
17	0.629	0.041
18	0.588	0.043
19	0.545	0.045
20	0.500	0.046
21	0.454	0.047
22	0.407	0.049
23	0.358	0.049
24	0.309	0.050
25	0.259	0.051
26	0.208	0.052
27	0.156	0.052
28	0.104	0.052
29	0.052	0.052
30	0.000	0.052
31	-0.052	0.052
32	-0.104	0.052
33	-0.156	0.052
34	-0.208	0.051
35	-0.259	0.050
36	-0.309	0.049
37	-0.358	0.049
38	-0.407	0.047
39	-0.454	0.046
40	-0.500	0.045
41	-0.545	0.043
42	-0.588	0.041
43	-0.629	0.040
44	-0.669	0.038
45	-0.707	0.036
46	-0.743	0.034
47	-0.777	0.032
48	-0.809	0.030
49	-0.839	0.027
50	-0.866	0.025
51	-0.891	0.023
52	-0.914	0.020
53	-0.934	0.017
54	-0.951	0.015
55	-0.966	0.012
56	-0.978	0.010
57	-0.988	0.007
58	-0.995	0.004
59	-0. 999	0.001
60	-1.000	

Measurement techniques

Sample application

Liquid samples

It is recommended that liquid samples be transferred to the prism surface using a pipette rather than a stirring rod or pouring directly from a beaker. After taking up the sample, any drips adhering to the outside of the pipette should be wiped off then discharge a few drops from the pipette directly onto the prism surface and close the prism box. This is of considerable importance when taking concentration measurements since thin films adhering to a stirring rod and exposed to the atmosphere can evaporate solvent rapidly when moved through the air, giving rise to errors in measurement.

Solid Samples

These are applied in the same manner as the test piece using a contact liquid. A surface must be prepared, polished as flat as possible and placed on the prism surface with the hinged prism opened out of the way. If the solid has an index higher than 1.65, methylene iodide can be used as a contact liquid (B+S code 10-61) in place of monobromonaphthalene which can only be used up to this limit.

Thin Films and contact lenses

Results may be obtained on most thin films but here a technique must be evolved, determined by the material and conditions.

Direct Application (Reflection mode)

Soft plastics and rubbery materials may be cured in a press between thin sheets of aluminium foil and reduced to a thickness of about 0.25mm. After preparation ensure that the prism surface is clean, strip off the foil on one side of the film and apply the exposed surface directly to the prism using no contact liquid.

Indirect Application (Reflection mode)

Resins and other low melting point solids are best prepared by melting them onto a thin glass substrate (B+S code 10-59). After hardening, the substrate should be placed on the prism surface with a contact liquid with the coated surface uppermost. Two borderlines will appear, one due to the sample, the other due to the substrate which may be previously found and ignored. It is essential that the refractive index of the substrate should be greater than that of the sample.

Dark samples (Reflection mode)

With certain materials of a non-transparent nature, such as thick oils, tar, marzipan etc., too much light may be absorbed in the sample film or be so scattered that definition is lost. In these cases, the trouble can generally be overcome by using reflection mode.

Specifications

Measurement range, refractive index (nD)	1.30 to 1.70
Scale resolution, refractive index (nD)	0.0005
Measurement range, °Brix	0 to 95
Scale resolution, °Brix	0.25
Operating temperature, °C	5 to 70
Temperature resolution, °C	0.1
Temperature accuracy, °C	±1
Ambient operating temperature, °C	5 to 40
Storage temperature, °C	5 to 40
Temperature module battery	LR44 alkaline 1.5V button cell
Dimensions, packed, cm	27 x 37 x 18
Footprint (bench space, cm)	22 x 12
Gross weight, kg	3.5
Net weight, kg	2.55

Spares and accessories

	B+S Code
Traceable calibration plate, silica: 1.45839 ± 0.0001 RI @ 20°C	72-200
Thin glass substrate for application of low melting point solids	10-59
Contact liquid, monobromonapthalene, for test plates to 1.65 RI	10-43
Contact liquid, methylene iodide, for test plates to 1.74 RI	10-61
Abbe 5 light source - LED (110 - 230V ~, 50/60 Hz)	44-520
Replacement measurement prism box assembly	44-590

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

Xylem Analytics' global brands have been leaders in the laboratory instrumentation market for decades, and are relied upon every day across more than 150 countries. Working in true partnership with our clients, we listen, learn and adapt to individual needs, offering deep application expertise built upon our long history of innovation in instruments and services. Our solutions for analysis, measurement and monitoring help enable many of today's modern laboratories and industrial processes, and provide our customers the trusted and high performing solutions they need to succeed.

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xylem
Let's Solve Water

Bellingham + Stanley
Xylem
Longfield Road
Tunbridge Wells
Kent, TN2 3EY
United Kingdom
Tel: +44 (0) 1892 500400
Email: sales.bs.uk@xyleminc.com
www.bellinghamandstanley.com

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