

Solutions for the Sugar Industry

Saccharimeter Selection Guide



Solutions for:

- Cane sugar milling and refining
- Beet sugar milling and refining
- Invert sugar
- Liquid sugar
- Confectionary sugar
- Molasses
- Brown sugar
- Ethanol

United States Department of Commerce
National Institute of Standards and Technology

NVLAP[®]

NVLAP LAB CODE: 200898-0
Accreditation to ISO/IEC 17025:2005

**RUDOLPH
RESEARCH
ANALYTICAL**

Rudolph Research Analytical, serving its customers
with Integrity, Quality, and Innovation for over fifty years.

TECHNICAL BULLETIN 910-S

Saccharimeter Solutions

The AUTOPOL® 589, 880, 880T provide 0.01°Z repeatability and accuracy, time proven measurement technology and the critical features necessary for today's sugar analysis.



Features Sugar Chemists Demand

Rudolph Research Analytical knows that Sugar Technologists around the world demand **24 hour operation, 7 days a week**. Regardless of the accuracy and budget demands, Rudolph Research has a solution. The reason we understand the sugar industry's demands and requirements is because **Rudolph has been serving the industry since 1940**. Throughout those fifty plus years of service, Rudolph has dedicated itself to manufacturing **quality instrumentation and providing superior technical and service support**, both directly and through its worldwide dealer network. This dedication is demonstrated by Rudolph's **installed base of over 5,000 instruments worldwide**, with many of those instruments still in operation after **25 years of service**.

Why Choose A Rudolph Saccharimeter?

Just listen to our customers:

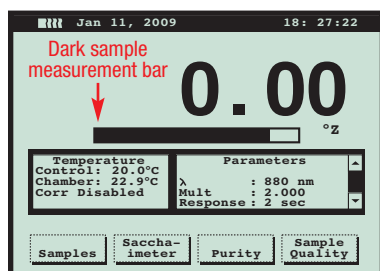
"...how pleased we are with the AUTOPOL instrument here at Lula-Westfield. Its performance has proven to be both reliable and accurate..."

– A.H. Newchurch, Jr., Chief Chemist, Lula-Westfield, USA

"...the biggest difference I've seen having the AUTOPOL 880 is how stable the readings are even with dark samples. There is no guessing the final answer."

– Arnel Negranza, Chief Chemist, Western Sugar, USA

Autopol® 589, 880 and 880T Important Features



Dual Wavelengths

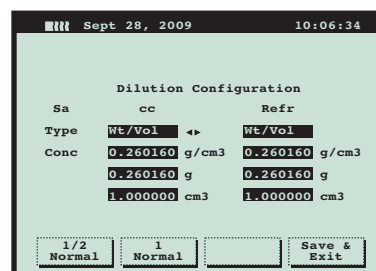
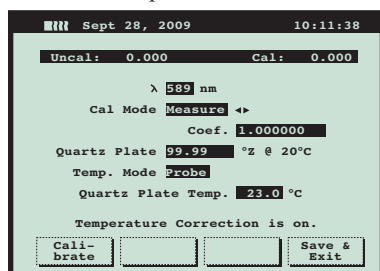
The most important feature of the AUTOPOL® models IIZ, 880 and 880T are their ability to measure at two wavelengths: **589 nm and 880 nm (NIR)**. Select 589 nm for conventional analysis using chemicals or lead clarifiers, or select 880 nm for polarimetric sugar

measurements in the near infrared (NIR). 880 nm is above the absorption level of most dark sugar factory solutions allowing measurement of filtered but non-lead clarified juices. The dark sample measurement bar gets darker in proportion to the darkness of the sample being measured. When the bar is completely dark the instrument has reached its measurement limit.

Automatic Calibration

Calibrating the AUTOPOL® is quick and simple. First, place a Rudolph Quartz Control Plate calibration standard on the optical rails and enter the Quartz Plate value in the appropriate window. Second, enter the temperature to correct the measurement to either the ICUMSA standard temperature of 20°C or the Tropical reference temperature of 27.5°C. Third, press 2 buttons and calibration is complete. (See

Technical Bulletin 913 for more details on Rudolph Calibration Standards)



Dilution and Cell Length Correction

Whether your sugar analysis requires a 25mm, 50mm, 100 mm or 200 mm cell, whether you use 1/2 normal (13g/100ml), 1/4 normal (6.5g/100ml) or full weight sugar solutions, the **AUTOPOL® 589, 880 and**

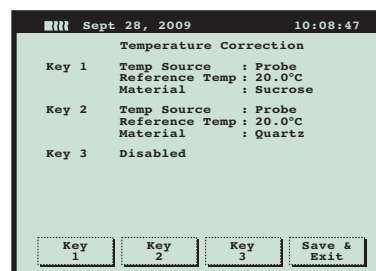
880T provide the correct multiplier to display the reading as if the sample were prepared as a 1 normal solution in a 200 mm optical pathlength cell.

Automatic Temperature Correction

All AUTOPOL® models have a temperature probe in the measurement compartment. The probe can be inserted into all 14 style, 40T style, 41T style and 33 style measurement cells.

The AUTOPOL® 880 displays the temperature source and type of correction. Utilizing factory programmed temperature coefficients the AUTOPOL® 880 can make the following types of temperature corrections:

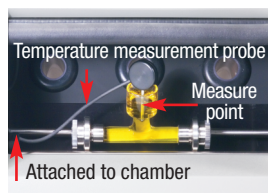
(1) A 30° C sucrose sample can be measured by the temperature probe and corrected to 20°C or 27.5°C or a customer defined temperature.



(2) A 29°C sucrose sample in a Type 14 center fill glass cell can be measured by the temperature probe inside the sample chamber and corrected to 20°C.

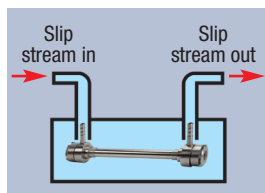
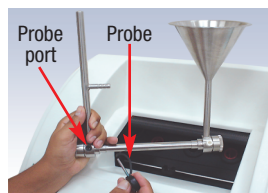
(3) A Quartz Plate measured at 25°C by the chamber temperature probe and then automatically corrected to 20°C.

Choosing a Cell and a Calibration Standard



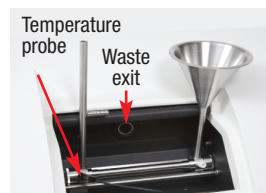
Temperature

All Autopol® Saccharimeters come with a Temperature Probe so that sample temperature can be displayed and printed. The temperature probe is built into the sample compartment and can be inserted into the polarimeter cell.



Automation and continuous sampling

Cells are available in 25mm, 50mm, 100mm and 200mm optical pathlengths with necessary fittings for any application.



Pour in sampling with temperature correction

Cells with stainless steel funnels and exit tubing available in 50mm, 100mm and 200mm optical pathlengths.



TempTrol™ Quartz Plates

allow for temperature control and correction in TempTrol™ Autopol 880s. Standard Quartz Plates allow for temperature correction only.

TempTrol™ Solutions for High Accuracy, Low Volume Laboratories

Autopol 880T



Rudolph 41T style cells allow for Electronic Temperature Control to a defined set temperature (i.e. 20.0°C or 27.5°C)

Primary temperature probe port

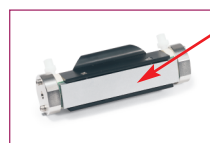
TempTrol™ flow cell with mating heating and cooling transfer surface

TempTrol™ Solution

Patented TempTrol™ Technology Eliminates the Need for a Water Bath



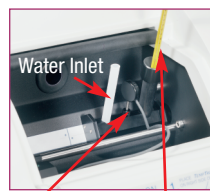
TempTrol™ heating and cooling transfer surface



TempTrol™ cell with mating heating and cooling transfer surface

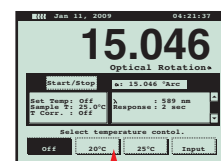


Place the TempTrol™ cell in your TempTrol™ equipped Autopol® 880T sample chamber to measure to within $\pm 0.2^\circ\text{C}$ of the ICUMSA specified temperature (normally 20°C or 27.5°C). Any temperature between 18°C and 35°C may be selected.



Probe NIST Thermometer

Rudolph provides a temperature validation cell with every TempTrol™ system. The temperature validation cell along with an optional NIST traceable thermometer is designed to validate the temperature control performance of the saccharimeter and cell to $\pm 0.2^\circ\text{C}$.



Temperature is selected via touch screen

Purity Software Definitions

The AUTOPOL® models 589, 880 and 880T always display Purity as if it were reading a 1 normal solution as defined in SPS-1: 3.1 The "normal sugar solution" is defined as 26.0160 g of pure sucrose weighed in vacuo and dissolved in water at 20.00°C to a final volume to 100.000 cm^3 . This corresponds to 26.000 g weighed in air under normal conditions (1013 mbar, 20°C , 50% relative humidity) and dissolved in water to a final volume of 100.000 cm^3 . Therefore, Rudolph displays:

%Sucrose = °Z reading corrected for dilution

Example: a 1/4 normal wt. solution reading 13.70°Z will read $(4 \times 13.70^\circ\text{Z})$ 54.80 %Sucrose.

%RDS-OP = Refractometer dissolved solids or Brix prior to dilution

Example: a 3:1 dilution having a refractometer Brix reading of 14.30 would read 42.90 %RDS-OP (14.30 Brix x 3)

%PURITY = %Sucrose x 100 x apparent density polynomial %RDS-OP


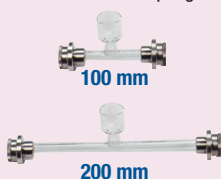



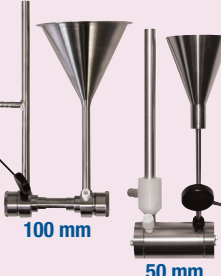




Purity Software Documentation

Fri June 10 2009



AMERICAN CRYSTAL
AUTOPOL 880 PURITY
Serial No. 6174

Wavelength: 880 nm
Cell Length: 200.00 mm
Temp. Corr. Sucrose 20.0°C

Count	Purity Meas.	Sacc. Meas.	Refr. Meas.	Sacc. Dilution	Refr. Dilution	Sample Name
1	49.86 %Purity	6.88 %Sucrose	13.80 %RDS-OP	0.260160 g/cm ³	1.000000 g/g	Green Juice
2	12.31 %Purity	6.88 %Sucrose	55.91 %RDS-OP	0.260160 g/cm ³	0.260160 g/cm ³	Pan Juice
3	24.61 %Purity	13.77 %Sucrose	55.94 %RDS-OP	0.260000 g/cm ³	0.260000 g/cm ³	Molasses 3
4	6.07 %Purity	3.40 %Sucrose	55.91 %RDS-OP	1.000000 g/g	0.260160 g/cm ³	Dark Juice

Models	Specification Highlights	Features and Benefits	Compatible Cells for all Models
Autopol® IZ 	<ul style="list-style-type: none"> • Purity Software: Optional with PC only • Measurement Range: $\pm 259^{\circ}\text{Z}$, $\pm 89.9^{\circ}\text{Arc}$ • Accuracy: 0.02°Z • Temperature Correction: 20°C, 27.5°C or user defined • Built-in Thermo Probe: Standard • Wavelength: 589nm • Prism: Glan Thompson Calcite 	<p>For 0.02°Z accuracy applications where budget is critical and 589 nm is the only wavelength needed. This instrument is popular for sugar applications that do not require ICUMSA measurement at the 880 nanometer wavelength.</p> <p>Rudolph does not use plastic polarizers on its less expensive models like other manufacturers do. Rudolph uses only Glan Thompson Calcite polarizers which cost 10x more than plastic polarizers.</p>	<p>14 style cells: for manual sampling</p>  <p>100 mm 200 mm</p>
Autopol® IIZ 	<ul style="list-style-type: none"> • Purity Software: Optional with PC only • Measurement Range: $\pm 259^{\circ}\text{Z}$, $\pm 89.9^{\circ}\text{Arc}$ • Accuracy: 0.02°Z • Temperature Correction: 20°C, 27.5°C or user defined • Built-in Thermo Probe: Standard • Wavelengths: 589nm, 880nm • Prism: Glan Thompson Calcite 	<p>For sugar mills that want to measure according to the ICUMSA non-lead procedure but whose application does not require the accuracy of Rudolph's more expensive models.</p> <p>Rudolph does not use plastic polarizers on its less expensive models like other manufacturers do. Rudolph uses only Glan Thompson Calcite polarizers which cost 10x more than plastic polarizers.</p>	<p>33 style cells: for pour-in sampling. Also available with water jackets for temperature control</p>  <p>200 mm</p>
Autopol® 589 	<ul style="list-style-type: none"> • Purity Software: Standard • Measurement Range: $\pm 259^{\circ}\text{Z}$, $\pm 89.9^{\circ}\text{Arc}$ • Accuracy: 0.01°Z • Temperature Correction: 20°C, 27.5°C or user defined • Built-in Thermo Probe: Standard • Wavelength: 589nm • Prism: Glan Thompson Calcite 	<p>For 0.01°Z accuracy sugar testing and payment for countries and applications where lead or other suitable clarifiers are still the norm. This model works at 589 nm and is not compliant with ICUMSA testing at 880 nm.</p> <p>Rudolph does not use plastic polarizers on its less expensive models like other manufacturers do. Rudolph uses only Glan Thompson Calcite polarizers which cost 10x more than plastic polarizers.</p>	 <p>100 mm 50 mm</p>
Autopol® 880 	<ul style="list-style-type: none"> • Purity Software: Standard • Measurement Range: $\pm 259^{\circ}\text{Z}$, $\pm 89.9^{\circ}\text{Arc}$ • Accuracy: 0.01°Z • Temperature Correction: 20°C, 27.5°C or user defined • Built-in Thermo Probe: Standard • Wavelengths: Standard - 589nm, 880nm Optional - 589, 587, 880, 882 Optional • TempTrol™ Electronic Temperature Control: Optional 	<p>This is Rudolph's most popular saccharimeter, it is used by 98% of all US sugar mills, 100% of all US customs labs and can be found in thousands of sugar mills around the world. It has 0.01 accuracy and is available in both 2 or 4 wavelength versions. TempTrol™ electronic cooling and heating is available as an option.</p> <p>This option is only suitable for air conditioned modern laboratories.</p>	<p>41T style cell: for pour-in sampling and electronic temperature control</p>  <p>200 mm</p>
Autopol® 880T 	<ul style="list-style-type: none"> • Purity Software: Standard • Measurement Range: $\pm 259^{\circ}\text{Z}$, $\pm 89.9^{\circ}\text{Arc}$ • Accuracy: 0.01°Z • Temperature Correction: 20°C, 27.5°C • Built-in Thermo Probe: Standard • Wavelengths: Standard - 589nm, 880nm Optional - 589nm, 587nm, 880nm, 882nm • TempTrol™ Electronic Temperature Control: Standard 	<p>This is Rudolph's latest and most advanced model. It was developed and tested in conjunction with labs testing pharmaceutical grade sugars. These labs require precise temperature control yet still want flow through cell type operation. For sugar trade labs and contract work that demands the best and most advanced saccharimeter in the world.</p> <p>This option is only suitable for air conditioned modern laboratories.</p>	<p>32 style cells: for automation</p>  <p>25 mm</p>

Additional Solutions

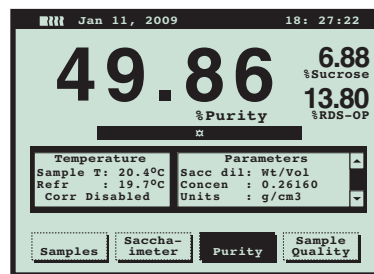
Ethanol or % Alcohol Measurement	Automation
Density Meter 	<p>Filter just 12ml of sample and measure Pol, BRIX, Color, Density and pH</p> 

Measuring Purity

Purity software is standard on the Autopol® 589, 880 and 880T, just add a Refractometer and read BRIX, POL and PURITY simultaneously on the Autopol's® large LCD backlit display.

Autopol® 880 Dual Wavelength Saccharimeter

Both instruments shown with pour in sampling

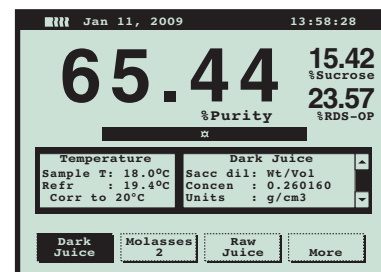


Large LCD Backlit Display

J157 Refractometer

Sample Specific Programs

The AUTOPOL® models 589, 880 and 880T come with PURITY software and **30 sample specific programs** which can be **pre-defined for specific juices**. This capability is **advantageous in factory environments** where the same type of samples are repeatedly measured. These programs allow for input parameters such as: **multiplier, wavelength, and temperature correction to be prespecified**. The PURITY software and a Refractometer also allow dilution on a weight/weight or weight/volume basis which can also be prespecified for each sample name. Each program can be labeled with an alphanumeric and assigned to one of the function keys. The factory operator simply presses the preassigned function key to start measurement.



Choosing A Refractometer For Your Purity System - See Technical Bulletin 929 for more details

Models	Specifications	Features and Benefits
J57HA 	<ul style="list-style-type: none"> Measurement Range: 1.33 - 1.53 RI; 0 - 95% Brix Accuracy: 0.00004 RI; 0.03 Brix Electronic Temperature Control: Fixed temperature selection: 20°C and 25°C 	<p>The J57HA's simple interface and easy to clean prism surface make it one of our most popular models for the sugar industry. Temperature control to 20°C and 25°C makes it perfect for molasses and high Brix samples. Measurement speed can be improved by using Temperature Correction in conjunction with Temperature Control, allowing measurements to be made accurately almost as soon as the sample is placed on the prism.</p>
J157-CC-AM 	<ul style="list-style-type: none"> Measurement Range: 1.33 - 1.53 RI; 0 - 95% Brix Accuracy: 0.00004 RI; 0.03 Brix Electronic Temperature Control: Flexible temperature selection between 15°C - 50°C 	<p>The J157-CC-AM is also quite popular with sugar factory labs. The non contact cover (CC) with built in electronic heating and cooling improves performance in harsh conditions. The Auto Measure (AM) feature allows the closing and opening of the cover to start and stop the measurement eliminating the need for the operator to touch the interface. Very popular for factory environments where air temperature varies dramatically: cold at night and hot during the day.</p>
J157-PTW and J157-KVP <p>Thumb screw</p> <p>Low volume funnel with integrated over flow</p>	<ul style="list-style-type: none"> Measurement Range: 1.33 - 1.53 RI; 0 - 95% Brix Accuracy: 0.00004 RI; 0.03 Brix Electronic Temperature Control: KVP: Select any temperature between 15°C - 30°C PTW: Select any temperature between 15°C - 40°C 	<p>The J157-PTW can be operated as a pour through refractometer when measuring juices and then by loosening one thumb screw and lifting the hinged presser the instrument can be used like a J57. This allows the J157-PTW to measure molasses and other high Brix samples.</p> <p>The J157-KVP has a vertical prism that allows suspended solids to fall past the prism surface instead of on to the prism. The small funnel volume design with integrated over flow funnel increases sample flushes and reduces spillage. The J157-KVP is often favored in applications with highly turbid low Brix samples.</p>

Choosing A Saccharimeter

Rudolph makes it easy to match a saccharimeter to your budget and application. The Autopol IZ and IIZ were designed for limited budget applications where 0.02°Z (ISS) accuracy are sufficient.

For the more demanding accuracy applications, Rudolph offers the Autopol 589, 880 and 880T models that have ±0.01°Z (ISS) accuracy, OD 4.0 dark sample penetration power and feature rich software.

Specifications*	Autopol® IZ	Autopol® IIZ	Autopol® 589	Autopol® 880	Autopol® 880T
Optical Wavelengths	589nm	589nm, 880nm	589nm	Standard - 589nm, 880nm Optional - 587nm, 882nm	Standard - 589nm, 880nm Optional - 587nm, 882nm
Wavelength Selection	Fixed	Selectable: 2 only	Fixed	Selectable: 2 standard, 4 optional	Selectable: 2 standard, 4 optional
Measuring Mode	Optical Rotation, Specific Rotation, Concentration, Sugar Degrees, °Z (ISS), User Defined Scale	Optical Rotation, Specific Rotation, Concentration, Sugar Degrees, °Z (ISS), User Defined Scale	°Z (ISS), Optical Rotation or User Defined Scale	°Z (ISS), Optical Rotation or User Defined Scale	°Z (ISS), Optical Rotation or User Defined Scale
Measuring Range	±89.9° Arc Optical Rotation, ±259 °Z (ISS)	±89.9° Arc Optical Rotation, ±259 °Z (ISS)	±89.9° Arc Optical Rotation, ±259 °Z (ISS)	±89.9° Arc Optical Rotation, ±259 °Z (ISS)	±89.9° Arc Optical Rotation, ±259 °Z (ISS)
Resolution	0.01° Arc Optical Rotation, 0.01 °Z (ISS)	0.01° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)
Reproducibility	0.01° Arc Optical Rotation, 0.01 °Z (ISS)	0.01° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)	0.001° Arc Optical Rotation, 0.01 °Z (ISS)
Accuracy	0.02° Z	0.02°Z (ISS) Sugar Degrees	0.01 °Z (ISS)	0.01 °Z (ISS)	0.01 °Z (ISS)
Measuring Scale	Degrees Arc, Optical Rotation, °Z (ISS)	Degrees Arc, Optical Rotation, °Z (ISS)	°Z (ISS)	°Z (ISS)	°Z (ISS)
Prism	Glan Thompson Calcite	Glan Thompson Calcite	Glan Thompson Calcite	Glan Thompson Calcite	Glan Thompson Calcite
Temperature Control	By external Water Bath	By external Water Bath	By external Water Bath	Standard - by external Water Bath Optional - TempTrol electronic heating and cooling 18°C - 35°C	TempTrol™ Automatic Electronic Heating & Cooling 18°-35°C (standard)
Temperature Correction	18°C - 40°C	18°C - 40°C	18°C - 40°C	18°C - 40°C	18°C - 40°C
TempTrol™ Accuracy	Temperature accuracy determined by Water Bath	Temperature accuracy determined by Water Bath	Temperature accuracy determined by Water Bath	Temperature accuracy determined by external Water Bath	±0.2°C TempTrol accuracy
Temp. Probe Range	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C
Temp. Probe Accuracy	±0.1°C	±0.1°C	±0.1°C	±0.1°C	±0.1°C
Measurement Time	5 measurements in less than 25 seconds (avg.)	5 measurements in less than 25 seconds (avg.)	12° per second	12° per second	12° per second
Light Source	Tungsten-Halogen 6V, 20W, avg. 2,000 hour life	Tungsten-Halogen 6V, 20W, avg. 2,000 hour life	Tungsten-Halogen 6V, 20W, avg. 2,000 hour life	Tungsten-Halogen 6V, 20W, avg. 2,000 hour life	Tungsten-Halogen 6V, 20W, avg. 2,000 hour life
Sample Chamber	Accepts sample tubes up to 200 mm	Accepts sample tubes up to 200 mm	Accepts sample tubes up to 200 mm	Accepts sample tubes up to 200 mm	Accepts sample tubes up to 200 mm
Data Storage	No	No	No	No	Yes
Communication Interface	Two RS232 serial ports, one parallel printer port	Two RS232 serial ports, one parallel printer port	Two RS232 serial ports, one parallel printer port and one auxiliary port	Two RS 232 serial ports, one parallel printer port and one auxiliary port	Two RS 232 serial ports, one parallel printer port and one auxiliary port, and 3 USB ports
Calibration	Automatic calibration via touch screen	Automatic calibration via touch screen	Automatic calibration via touchscreen	Automatic calibration via touchscreen	Automatic calibration via touchscreen
Purity Software	Optional with PC	Optional with PC	Standard	Standard	Standard
Connection to Refractometer	Not available	Not available	Standard	Standard	Standard
Display	7.5 cm x 10 cm Graphics LCD, 320 x 240 dots cold fluorescent back lit	7.5 cm x 10 cm Graphics LCD, 320 x 240 dots cold fluorescent back lit	7.5 cm x 10 cm Graphics LCD, 320 x 240 dots cold fluorescent back lit	7.5 cm x 10 cm graphics LCD, 320 x 240 dots cold fluorescent back lit	10.4 " diagonal, 800-600 pixels, color, Flat Panel Monitor with resistant Touch Screen Interface, 200 nits brightness, gasketed for spill protection
User Interface	Touchscreen	Touchscreen	Touchscreen	Touchscreen	Touchscreen
Automatic Sensitivity Control	Measures samples with transmittance as low as .1% (up to OD 3.0)	Measures samples with transmittance as low as 0.1% (up to OD 3.0)	Measures samples with transmittance as low as 0.01% (up to OD 4.0)	Measures samples with transmittance as low as 0.01% (up to OD 4.0)	Measures samples with transmittance as low as 0.01% (up to OD 4.0)
Input Power	100 - 240V, 50/60 Hz	100 - 240V, 50/60 Hz	100 - 240 V, 50/60 Hz	100 - 240V, 50/60 Hz	100 - 240V, 50/60 Hz
Operating Dimensions	24.3" W x 12.7" H x 17.5" D 617 mm W x 323 mm H x 445 mm D	24.3" W x 12.7" H x 17.5" D 617 mm W x 323 mm H x 445 mm D	35" W x 10.5" H x 17" D 890 mm W x 267 mm H x 432 mm D	35" W x 10.5" H x 17" D 890 mm W x 267 mm H x 432 mm D	32"W x 11.5"H x 18"D 813 mm W x 292 mm H x 457 mm D
Shipping Dimensions	31" W x 28" H x 26" D 787.4 mm W x 711.2 mm H x 660.4 mm D	31" W x 28" H x 26" D 787.4 mm W x 711.2 mm H x 660.4 mm D	42" W x 24" H x 21" D 1066.8 mm W x 609.6 mm H x 533.4 mm D	42" W x 24" H x 21" D 1066.8 mm W x 609.6 mm H x 533.4 mm D	43" W x 28" H x 23" D 1411 mm W x 919 mm H x 722 mm D
Operating Weight	42 lbs. (19.05 kg)	42 lbs. (19.05 kg)	85 lbs. (39 kg)	85 lbs. (39 kg)	95 lbs. (43 kg)
Shipping Weight	72 lbs. (32.6 kg)	72 lbs. (32.6 kg)	120 lbs. (54.5 kg)	120 lbs. (54.5 kg)	130 lbs. (59 kg)

*Unless otherwise stated, specifications are based on 589nm