RUDOLPH RESEARCH ANALYTICAL

TECHNICAL BULLETIN 913



Cells and Calibration Standards

Cells, Traceable Calibration Standards through NIST and Filling Options for Automatic Polarimeters



Rudolph Research Analytical serving its customers with Integrity, Quality, and Innovation for over 50 years.

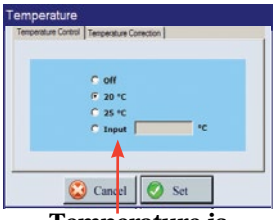
Rudolph subjects itself to a variety of industry accreditations and outside examination. Visit our website to learn how these apply to your purchase.

Two Temperature Control Solutions

1. Patented TempTrol® Technology Eliminates the Need for a Water Bath



TempTrol® heating and cooling transfer surface



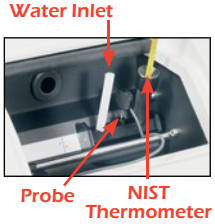
Temperature is selected via touch screen.



TempTrol® cell mating heating and cooling absorption surface



Place the TempTrol® cell in your TempTrol® equipped Autopol® sample chamber to measure to within ±0.2°C of the USP, EP, JP or BP specified temperature (normally 20°C or 25°C ±0.5°C)



Rudolph provides a temperature validation cell with every TempTrol® system. The temperature validation cell along with an optional NIST traceable Note 1 **thermometer is designed to validate the temperature control performance of the polarimeter and cell to ±0.2°C**

2. Temperature Control With Water Bath





Picture A

As seen above, almost all Rudolph Research Analytical jacketed cells come standard with quick release fittings which allow cells to be easily removed from the sample chamber. Tubing is held in place by rubber gasketing on top of the trough and the door. Optional stopper (choose "S" after the cell part no.) for evaporative samples (Picture A).

Temperature control is obtained through the use of an external water bath and a jacketed cell (Figure 1).

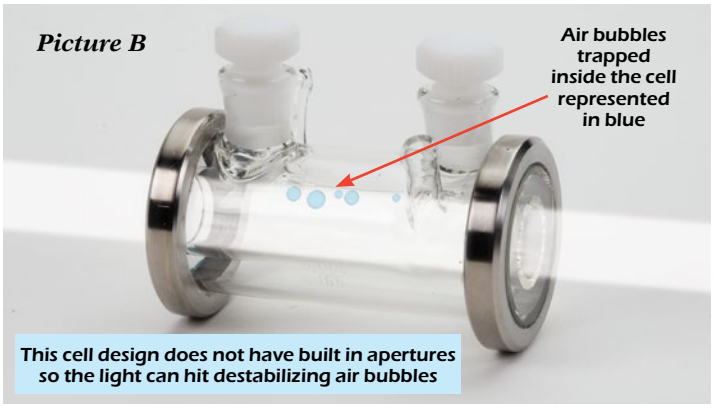
Figure 1



Better By Design

Many Rudolph Polarimeter Cell designs offer significant advantages over traditional fused end glass cell designs as shown in Picture B. All glass cells are easily broken and often build up optically active residue on the inside of the glass ends. Also these cells do not have built in apertures so the light passing through the sample is easily affected by small air bubbles caught inside the cell as shown in Picture B. Rudolph does offer this style cell for those customers who prefer a fused glass end but doesn't recommend them.

Picture B

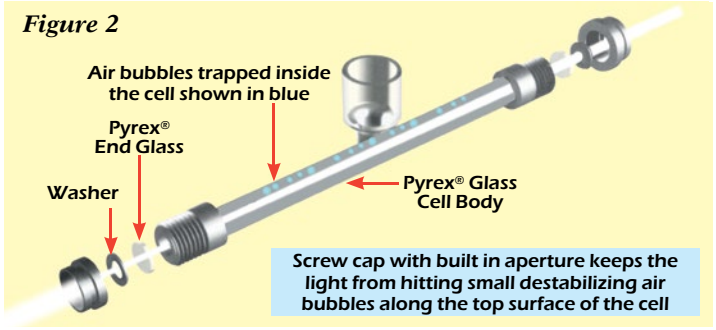


This cell design does not have built in apertures so the light can hit destabilizing air bubbles

Rudolph Polarimeter Cells with built in apertures eliminate these problems. The stainless steel screw ends have apertures that are smaller than the internal diameter of the cell body to avoid the problem of the light being disturbed by small air bubbles along the surface of the cell. This design results in better measurement stability (Figure 2).

As shown below, the screw caps have precision apertures which reduce the beam diameter to less than the internal diameter of the cell so that, when the cells are aligned with the beam, internal sidewall reflections and consequent depolarizing effects are minimized.

Figure 2



Screw cap with built in aperture keeps the light from hitting small destabilizing air bubbles along the top surface of the cell

Easy Cleaning

Another advantage over fused end cells is that screw caps, washers, and end plates are easily removed for cleaning the glass ends, sample cell interiors, or for replacement of the washers and end glass. To reassemble the cell requires following the configuration of Figure 2 and then applying finger tight pressure to the screw caps. As the screw caps are turned, the washers are compressed against the end glass creating a leak proof seal with the precision ground cell ends. Minimal screw cap pressure and the compressibility of the washer ensures a tight seal without causing stress induced birefringence in the glass end plates.

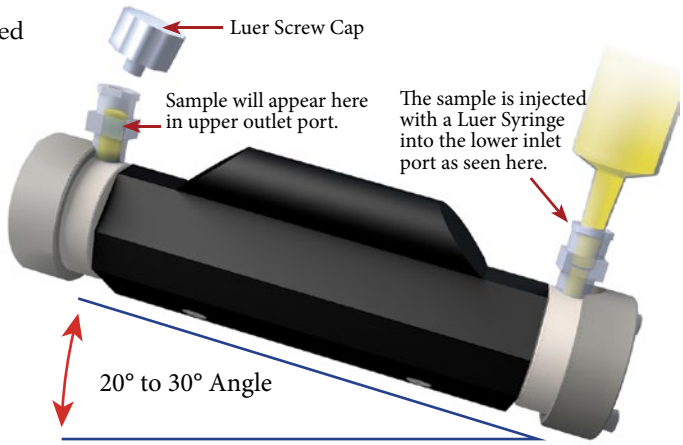
How to Fill Cells Manually

Rudolph Research Polarimeter Sample Cells

Rudolph Research Polarimeter Sample Cells are designed to be easily filled and cleaned with a Luer syringe.

When held at the correct angle and filled using the lower inlet port, the cell is filled with almost no possibility of leaving an air bubble in the cell. Filling from the lower inlet port forces any air bubbles up and out of the upper outlet port.

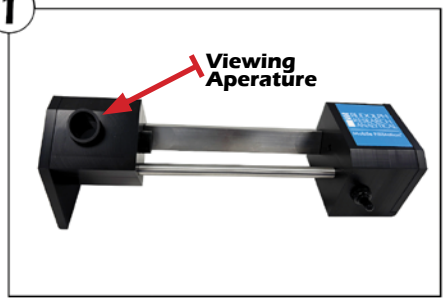
Rudolph cells are unlike other manufacturers' cells as they are uniquely designed to keep small air bubbles out of the light path. Filling the cell is as simple as holding the cell at a slight upward angle and filling from the bottom inlet using a Luer Syringe. When the sample appears near the top outlet port, simply place the Luer cap on the upper port and then lower port. Your cell is now filled, capped and air bubble free. Cells must be clean and dry to ensure proper filling with minimum sample.



How to use the Rudolph Research Polarimeter Cell FillStation®

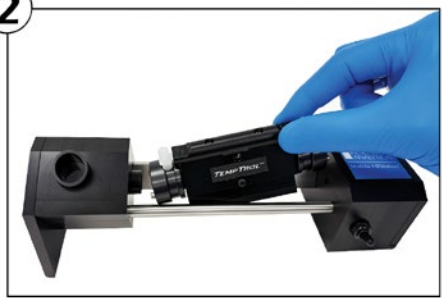
For users who prefer not to hold the cell while working with highly acidic or basic samples, the Rudolph Cell Fill Station® should be used.

1



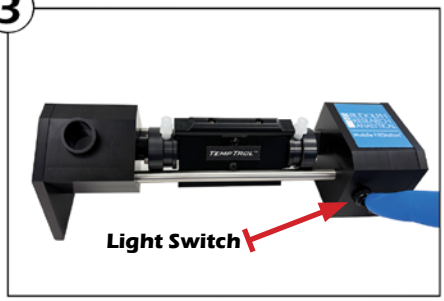
By design, the FillStation® will hold the cell at a suitable angle.

2



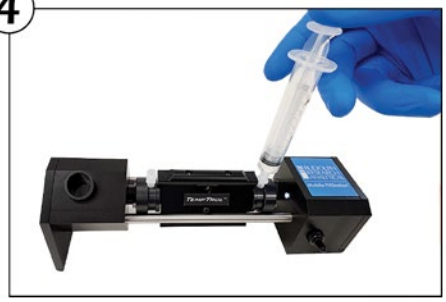
Place a Polarimeter cell into the Rudolph FillStation®.

3



Turn the FillStation® light on. The light will turn off automatically after a few minutes.

4



Make sure the cell is always clean and dry.
Use compressed air and acetone for this process. Fill the cell from the lower inlet port with a Luer Syringe only.
As the cell becomes filled and sample begins to appear at the upper inlet, cap off the upper then lower inlet port. Your cell is now filled and air bubble free.

5



The FillStation® creates a light image that will go from darker to a bright white circle when the cell is filled and air-bubble free. A bubble free cell shows an illuminated white circle as shown on the right.



Please Note:

Filling a Rudolph Polarimeter cell is easy and you can be assured of an air bubble free sample cell. It is important to note that when using highly acidic or basic solution samples the cell should not be filled in the Polarimeter; doing so may allow spillage into the instrument which, over time, may damage the instrument.

The Rudolph Polarimeter Cell Fill Station® accessory is available for all Rudolph Autopol® Polarimeters and is included free of charge with Autopol® V, Autopol®V PLUS, and Autopol® VI Polarimeter Models.

Reading Your FillStation®



Empty Cell

Cell Being Filled

Air Bubbles detected during filling process

Cell filled and free of air bubbles

Rudolph Research Analytical 55 Newburgh Road, Hackettstown, NJ 07840 USA ▪ Phone: 973-584-1558 ▪ info@rudolphresearch.com ▪ www.rudolphresearch.com

Call Us To Select A Cell That Meets Your Application

Type 40T Ceramic TempTrol™ Cell



Type 40T TempTrol® Cells are for laboratories that work with strong acids and bases such as 6 Molar HCl; the Ceramic Quartz Polarimeter Sample Cell addresses the issues associated with corrosive samples. Rudolph's exclusive design also incorporates an improved sample flow through the cell to reduce cavitation and air bubbles. Available only from Rudolph, the Ceramic Quartz Cell is available on all models and comes standard on the Autopol® IV-T, Autopol® V, Autopol® V PLUS and Autopol® VI, a Rudolph exclusive offering.

Part Number		ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
40T-3.0-100-.9-C	*	3.0	100	0.9
40T-3.0-50-.6-C	*	3.0	50	0.6
40T-5.0-100-2-C	*	5.0	100	2.0
40T-5.0-200-4-C	*	5.0	200	4.0
40T-5.0-50-1-C	*	5.0	50	1.0
40T-5.0-25-0.5		5.0	25	0.5
40T-5.0-10-0.2		5.0	10	0.2

Type 60T Ceramic TempTrol® Cell



Type 60T TempTrol® Ceramic Polarimeter Sample Cells are constructed of Ceramic Quartz which is highly resistant to caustic samples such as 6 molar HCl. All cells come with Luer® lock fittings for easy filling with a plastic syringe or pipette. The cells have removable PTFE collars that allow for easy cleaning and glass cell end replacement. *Select Type 60TFT for Automation and/or HP for High Pressure Applications.

Part #	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
60T-3.0-50-.6-CU	3.0	50	0.6
60T-5.0-50-1-CU	5.0	50	1.0
60T-3.0-100-.9-CU	3.0	100	0.9
60T-5.0-100-2-CU	5.0	100	2.0
60T-5.0-200-4-CU	5.0	200	4
60TFT-3.0-50-.6-CU	3.0	50	0.6
60TFT-5.0-50-1-CU	5.0	50	1.0
60TFT-3.0-100-0.9-CU	3.0	100	0.9
60TFT-5.0-100-2-CU	5.0	100	2.0

Type 14 Glass



Type 14 Polarimeter Sample Cells: Pyrex glass with center well for easy filling via pour-in method or with a flexible tipped pipette. Glass or Delrin stoppers are available as an option.
Select "S" if you want a glass stopper. Select "DT" if you want a Delrin stopper with hole for Thermo Probe.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
14-8.5-50-3.0-S/DT	8.5	50	3.0
14-4.0-100-1.5-S/DT	4.0	100	1.5
14-8.5-100-6.0-S/DT	8.5	100	6.0
14-4.0-200-2.8-S/DT	4.0	200	2.8
14-8.5-200-12-S/DT	8.5	200	12

Type 14J Glass Jacketed



Type 14J Jacketed Polarimeter Sample Cells: Pyrex glass with center well. The main body of the cell is completely surrounded by a stainless steel jacket with quick release fittings at each end for circulation of temperature control fluids. Select "S" if you want a glass stopper. Select "DT" if you want a Delrin stopper with hole for Thermo Probe. Select HT for temperatures above 160ºC.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
14J-4.0-100-1.5-S/DT	4.0	100	1.5
14J-8.5-100-6.0-S/DT	8.5	100	6.0
14J-8.5-200-12-S/DT	8.5	200	12

Type 29 Stainless Steel



Type 29 Flow-Through Sample Cells: Stainless steel with tubulations at each end for circulation of sample liquids. Designed so that sample flow washes interior windows eliminating dead volume in the optical path. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell.

Part #	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
29-8.5-50-5	5.0	50	5.0
29-8.5-100-10	8.5	100	10
29-8.5-200-15	8.5	200	15

Type 29J Jacketed Stainless Steel



Type 29J Flow-Through Jacketed Sample Cells: Type 29 but with a stainless steel jacket surrounding the main body of the cell for circulation of temperature control fluids. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
29J-8.5-100-10	8.5	100	10
29J-8.5-200-15	8.5	200	15

Type 30 Stainless Steel



Type 30 Sample Cells: Stainless steel with a well at either end for easy filling. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
30-8.5-100-10	8.5	100	10
30-8.5-200-15	8.5	200	15

60T and 40T Ceramic Cells come with a Lifetime Warranty

Type 30J Jacketed Stainless Steel



Type 30J Stainless Steel Jacketed Sample Cells: Type 30 with stainless steel jacket surrounding the main body of the cell for circulation of temperature control fluids. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
30J-4.0-100-3.7	4.0	100	3.7
30J-8.5-100-10	8.5	100	10
30J-8.5-200-15	8.5	200	15

Type 61T Stainless Steel



Type 61T TempTrol® Flow-Through Sample Cells: Stainless steel funnel and exit tubing. The cell has a built-in temperature port which allows the temperature sensor and temperature control system to automatically measure and control the temperature inside the cell to 20°C, 25°C or any input temperature within the range of the TempTrol® temperature control system.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
61T-8.5-100-10	8.5	100	10
61T-8.5-200-15	8.5	200	15

Type 33 or 33J Jacketed Stainless Steel



Type 33 or 33J Flow-Through Sample Cells: Stainless steel funnel and exit tubing. This cell has a built-in temperature port which allows the temperature sensor to automatically measure the sample temperature inside the cell and send the temperature to the Autopol® IV or Autopol® 880 for correction to 20°C or 25°C. It comes in jacketed and unjacketed versions – Select "J" for jacketing.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
33-8.5-100-10	8.5	100	10
33-8.5-200-15	8.5	200	15
33J-8.5-100-10	8.5	100	10
33J-8.5-200-15	8.5	200	15

Type 32 Stainless Steel



Type 32 Small Volume Sample Cells: Stainless steel with small inlet and outlet ports on both ends of the cell for filling with a pipette with HPLC fittings. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell. *Select HP for Automation or High Pressure Applications.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
32-2.5-10-0.05	2.5	10	.05
32-2.5-50-0.25	2.5	50	.25
32-2.5-100-0.5	2.5	100	0.5
*32-5-25-0.5/HP	5.0	25	0.5
*32-5-50-1.0/HP	5.0	50	1.0
*32-5-100-2.0/HP	5.0	100	2.0

Type 32J Jacketed Stainless Steel



Type 32J Small Volume Jacketed Sample Cells: Type 32 with stainless steel jacket surrounding the main body of the cell for circulation of temperature control fluids. Also available with HPLC fittings. The cell has a built-in temperature port which allows the temperature sensor system to automatically measure the temperature inside the cell.

Part Number	ID (mm)	Cell Length (±0.02mm)	Sample Volume (ml)
32J-5-50-1.0	5.0	50	1.0
32J-2.5-100-0.5	2.5	100	0.5
32J-5-100-2.0	5.0	100	2.0



- **Lifetime Warranty against breakage on Stainless Steel and Ceramic Quartz Cells.**
- **Acid Resistant Lifetime Warranty on Ceramic Cells.**
- **No Warranty on 14 and 14J Glass Cells.**
- **Cell Optical Path Length Accurate to ±0.02 mm**

Cells That Meet The Most Demanding Applications

Selection

With over 50 cells to choose from, Rudolph Research Analytical has a cell to meet every application.

AUTOPOL® Accepts Sample Cells from 10mm to 200mm Long

Some polarimeters accept only special sample cells, with maximum lengths of 100mm. The Autopol® accepts cells up to 200mm long. A 200mm sample cell offers twice the sensitivity when measuring the same solution in a 100mm cell. This additional optical path length is especially useful for solutions having small rotations. For precious samples and essential oils with large optical rotations, cells with only 0.05ml volumes and 10mm optical path lengths are available.

Easy Filling

Sample solutions are either poured, injected with a syringe into an inlet port or pipetted into the center well. Air bubbles are released by tilting cells side to side or to one side while filling. Flexible tipped pipettes capable of reaching from the center well to either end of the sample can be helpful in filling narrow bore center fill cells.



Pour In Sampling Capability

Rapid operation is achieved by using a Type 33 or 41T Flow Through Polarimeter Sample Cell as seen in Picture C. Once the sample cell is filled, each successive sample poured into the funnel will displace the previous sample through the drain tube. This method eliminates opening and closing the sample chamber door and interchanging sample cells. Measurements can be made about as rapidly as successive samples can be poured.

Micro Volumes For Chiral Detection After HPLC

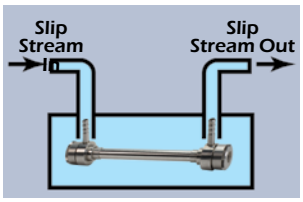
If your application demands 1ml or less, Type 32 Cells offer less than 0.5ml volumes. These cells come standard with HPLC fittings which transform your polarimeter into a chiral detector when connected to a chiral column after HPLC (Picture D).

Temperature Correction

For sucrose or other high volume applications where the temperature coefficient is known, a 33 Cell can be used as in Picture C. This cell has a built-in temperature port which, when the temperature probe is inserted, automatically measures the sample temperature inside the cell and sends the temperature to the Autopol® IV or Autopol® 880 for correction to 20ºC, 25ºC or any customer specified temperature.

Select the Ceramic Cell when measuring Acids and Riboflavin.

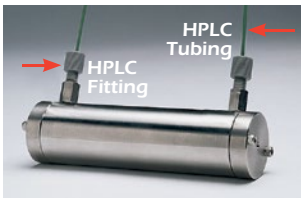
C option indicates Ceramic Quartz which is acid resistant.



Continuous Sampling

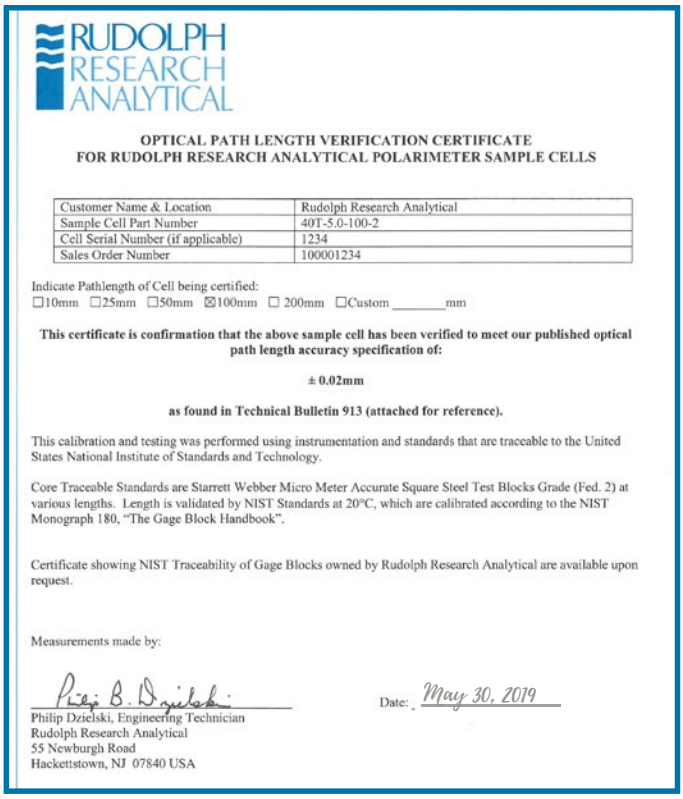


Picture C: Pour In Sampling With Temperature Correction



Picture D: Micro Volumes for HPLC

NIST Traceable Cell Length Certificate Certifying Optical Plate Length Accuracy ±0.02mm Optional at Time of Purchase (Note 1)



RUDOLPH RESEARCH ANALYTICAL

OPTICAL PATH LENGTH VERIFICATION CERTIFICATE
FOR RUDOLPH RESEARCH ANALYTICAL POLARIMETER SAMPLE CELLS

Customer Name & Location	Rudolph Research Analytical
Sample Cell Part Number	40T-5.0-100-2
Cell Serial Number (if applicable)	1234
Sales Order Number	100001234

Indicate Pathlength of Cell being certified:
☐10mm ☐25mm ☐50mm ☒100mm ☐ 200mm ☐Custom _____mm

This certificate is confirmation that the above sample cell has been verified to meet our published optical path length accuracy specification of:

± 0.02mm

as found in Technical Bulletin 913 (attached for reference).

This calibration and testing was performed using instrumentation and standards that are traceable to the United States National Institute of Standards and Technology.

Core Traceable Standards are Starrett Webber Micro Meter Accurate Square Steel Test Blocks Grade (Fed. 2) at various lengths. Length is validated by NIST Standards at 20°C, which are calibrated according to the NIST Monograph 180, "The Gage Block Handbook".

Certificate showing NIST Traceability of Gage Blocks owned by Rudolph Research Analytical are available upon request.

Measurements made by:

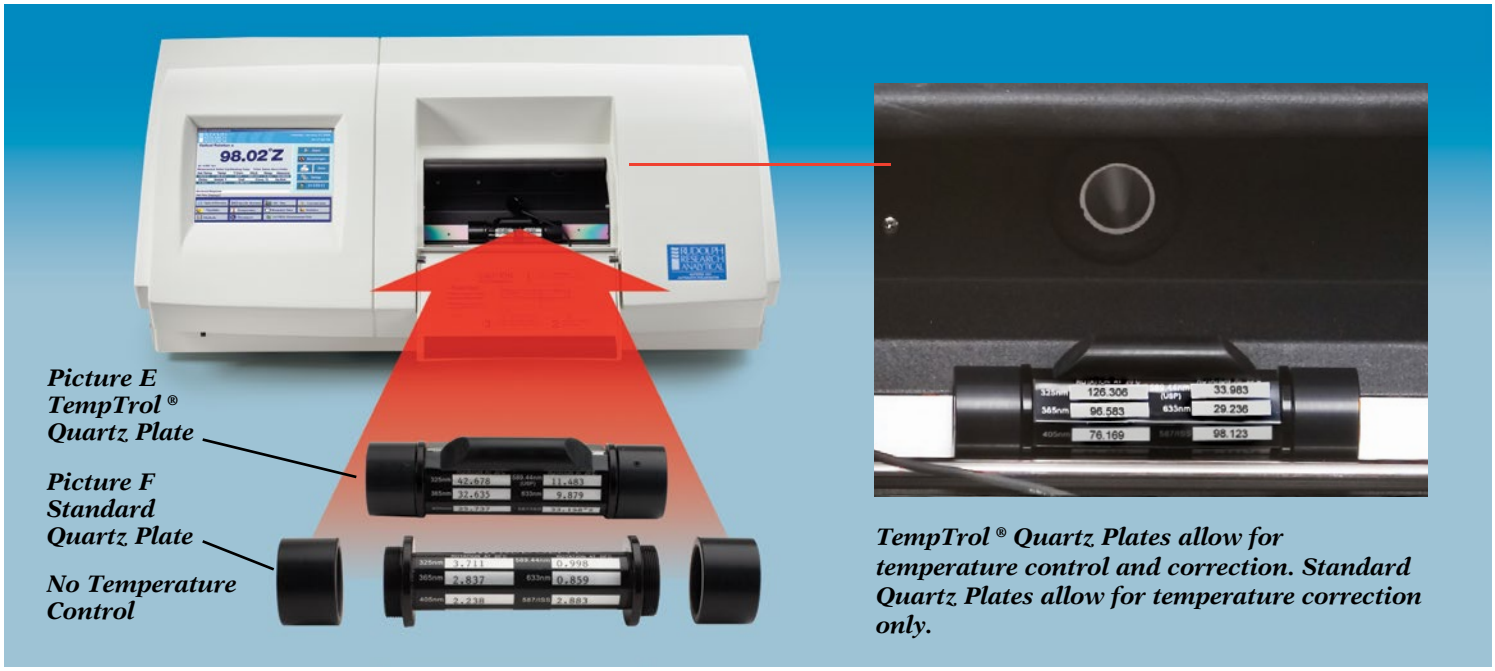
Philip B. Dzielski

Philip Dzielski, Engineering Technician
Rudolph Research Analytical
55 Newburgh Road
Hackettstown, NJ 07840 USA

Date: May 30, 2019

Note 1: Rudolph's accreditation body, has indicated that the words NIST traceable are assumed to mean and be changed wherever possible to: Standards produced by Rudolph Research Analytical are traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other National Metrology Institute (NMI) claiming competence in subject matter. Further metrological traceability is defined by the Bureau International des Poides et Mesures (BIPM) as the "property of a measurement result whereby the results can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty."–JCGM 200:2012

NIST Traceable Calibration Standards [Note 1]



TempTrol ® Quartz Plates allow for temperature control and correction. Standard Quartz Plates allow for temperature correction only.

Manufactured to NIST and ICUMSA Standards

Rudolph Research Analytical Quartz Control Plates provide a permanent calibration standard for polarimeters and saccharimeters. Every Rudolph calibration standard is manufactured using extremely stable crystalline quartz which is manufactured and polished to specific planeness, parallelism, purity and axis standards. These standards meet or exceed the specifications outlined on Page 61 of the National Institute for Standards and Technology (NIST) Circular C440 or as laid down by the International Commission for Uniform Methods of Sugar Analysis (ICUMSA). Each Quartz Plate comes complete with a label showing calibration at 11 different wavelengths (Picture G), a protective box and a NIST Traceable Certificate. [Note 1]

Only Rudolph Provides:

3 RotationTempTrol®
NIST Traceable Quartz [Note 1]
Calibration Standards
Automated Version Shown Below
Combine Plate 1 and 2 for a combined rotation close to zero



Picture H

Positive
Rotating Plate 1

Negative
Rotating Plate 2

Selecting a Quartz Calibration Standard

Many rotations are available but generally available stock rotations are listed on back page. Quartz Plates come in single and 3 rotation. Single Quartz Plates have a single rotation value at each wavelength and are calibrated in ˚Arc (Optical Rotation) and ˚ISS/˚Z (Sugar Degrees). 3 Rotation Quartz Plates are also calibrated in ˚Arc and ˚ISS/˚Z, but have three rotation values at each wavelength(Picture F). This is possible because each plate is made up of one left or levo turning Quartz Plate (i.e. –10˚ Arc) and one right or dextro turning plate (i.e. +12˚ Arc) which may be used separately or together for a combined rotation of 2˚Arc (12˚–10˚). Every Rudolph Research Analytical Quartz Plate is manufactured to a reported uncertainty of ±0.002° Arc at 589. Please contact the factory for the Quartz Plate that is best suited for your needs.

Picture G: Quartz Plate Label
Showing calibration values at 11 different wavelengths

QUARTZ CONTROL PLATE CALIBRATION STANDARD
www.rudolphresearch.com

Serial No.	12288	Cal. Date	21-NOV-2021

RUDOLPH
OPTICAL ROTATION 20° C

325nm	55.761	589.44nm Vac	15.002
365nm	42.639	633nm	12.907
405nm	33.627	587/ISS	43.323
436nm	28.684	589/ISS	43.327
546nm	17.634	880/ISS	43.403
589.3nm Air	15.002	882/ISS	43.402

Call Us To Select A Calibration Standard That Meets Your Application

Rudolph Research Analytical is the only Quartz Plate manufacturer in the world accredited by and traceable through NIST [Note 1] with accuracy of ± 0.002 degrees optical rotation at 589nm.

TempTrol® Quartz Plates indicated by the letter "T" have the facility for automatic temperature control when purchased with a TempTrol® equipped polarimeter. Type A600 is specific for the Series 4 (S4) Autopol® V Plus/Autopol® VI with Automatic Calibration.

Every Quartz Control Plate is calibrated by Rudolph Research Analytical and is traceable to the National Institute of Standards and Technology.

Recalibration of Quartz Control Plates

Neither NIST nor ICUMSA provide guidelines for the frequency of Quartz Control Plate Recalibration. Since quartz is optically stable over time, changes in its optical rotation are the result of optical stress or surface scratches caused by physical handling. Therefore, it is the opinion of Rudolph Research Analytical that recalibration of a Quartz Calibration Standard every two to three years is satisfactory.

Single Rotation TempTrol® Plate

TempTrol® Quartz Control Plate Version A700T-1 with single rotation 11.483° Arc



TempTrol® Quartz Control Plate(QCP) - A700T-1
Standard Quartz Control Plate(QCP) - A700-1
Automatic Calibration(QCP) - A600-1-X-POS

Standard Rotations at 589 nm in °Arc : 10.5°, 11.5°, 12°, 12.5°, 13°, 15°, 16°, 20°, 21.5°, 34°, 34.62°
Accuracy at 589 nm: ±0.002° Arc (ISS)

Standard Rotations at 589 nm in °Z(ISS): 30.32°, 33.21°, 34.66°, 36.10°, 37.54°, 43.32°, 46.21°, 57.76°, 62.09°, 98.19°, 99.98°
Accuracy at 589 nm: ±0.01°Z (ISS)

TempTrol® Quartz Control Plate 302T
Standard Quartz Control Plate 302
Automatic Calibration(QCP)(Picture H) - A600-1-X-NEG

Standard Rotations at 589 nm in °Arc: -10°, -10.75°, -11°, -12°, -13°, -15°, -16°
Accuracy at 589 nm: ±0.002° Arc

Standard Rotations at 589 nm in °Z(ISS): -28.88°, -31.04°, -31.76°, -34.65°, -37.54°, -43.32°, -46.20°

Accuracy at 589 nm: ±0.01°Z (ISS)

TempTrol® Quartz Control Plate 300T-S
Standard Quartz Control Plate 300-S

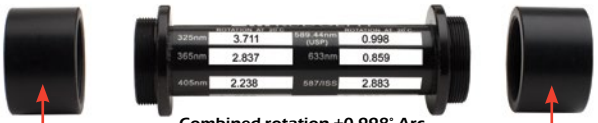
Custom rotations at 589 nm in °Arc:
Customer Selected between +10° to +34.62° Arc
Accuracy at 589 nm: ±0.002° Arc

Custom rotations at 589 nm in °Z(ISS):
Customer Selected Between +28.88°Z to 99.98°
Accuracy at 589 nm: ±0.01°Z (ISS)

Quartz Control Plates are to be within ±0.5 degrees Arc or ±1.5 degrees ISS of the customer's specified rotation.

3 Rotation Standard Quartz Plate

Standard Quartz Control Plate Version A700-2 with 3 rotations



TempTrol® Quartz Control Plate - A700T-2 Standard Quartz Control Plate - A700-2
Automatic Calibration QCP - A600-2-X-POS

Standard Rotations at 589 nm in °Arc: Approximately: 1°, 2°, 6°
Accuracy at 589 nm: ±0.002° Arc

Standard Rotations at 589 nm in °Z(ISS): 2.89°, 5.78°,17.33°
Accuracy at 589 nm: ±0.01°Z (ISS)

TempTrol® Quartz Control Plate 302T-S
Standard Quartz Control Plate 302-S

Standard Rotations at 589 nm in °Arc: -1° to -10° Arc
Accuracy at 589 nm: ±0.002° Arc

Standard Rotations at 589 nm in °Z(ISS): -2.89 to -28.89
Accuracy at 589 nm: ±0.01°Z (ISS)

TempTrol® Quartz Control Plate 301T-S
Standard Quartz Control Plate 301-S

Has a combined rotation between +1 to +10 angular degrees (°Arc) or +2 to +30 International Sugar Scale degrees (°ISS)/(°Z). The Quartz Control Plate consists of one left and one right turning quartz plate in separate cells, each of which can be removed from the cell holder for using either plate separately or together for a combined rotation. Quartz Control Plates are to be within ±0.5 degrees Arc or ±1.5 degrees ISS of the customer's specified rotation.

Custom rotations at 589 nm in °Arc: Customer Selected between +1° to +10° Arc
Accuracy at 589 nm: ±0.002° Arc

Rotations at 589 nm in °Z(ISS): Customer Selected between 2.89-28.98
Accuracy at 589 nm: ±0.01°Z (ISS)

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