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1. Preface

A polarimeter is the instrument for optical rotation measurement of optically active substance. You can identify this material's concentration, content and purity by the determination of optical rotation. The instrument is widely used in such industrial areas, e.g., oil, sugar, pharmaceutical, food, chemicals, also in relevant colleges and scientific research institutions.

IP-digi series automatic polarimeter uses light emitting diode as the light source to avoid the frequent replacement of the sodium lamp. The instrument adopts the color LCD touch screen for easy operation. This series instruments also have the temperature control function, you can control the sample temperature by using a special supplied temperature control cell.

2. Installation

Please read this instrument manual carefully before using the instrument. Install the instrument according the following steps:

- Check the supplied goods according to the packing list.
- Take out the instrument from the packaging box carefully and place it on a firm, stable workbench. Avoid any vibration. There are at least 20cm space around the instrument for the instrument ventilation.
- Connect the power line to the main power. The instrument needs a 220V 50Hz AC power supply. (The main switchboard should be equipped with air-protection switch, if the power voltage is instability , an AC electronic voltage stabilizer is needed.)
- Make sure that the instrument is grounded before use.
- The instrument should be kept dry, avoid moisture and corrosive gas erosion. An air-conditioned working environment is preferred.

3. Brief Introduction

3.1 Measuring principle

The optical rotation is related to the wavelength of the light source used, the path length of the optical materials, the temperature and the concentration of the sample solution. It can be calculated by the specific rotation multiplied by optical pathway L multiplied by the concentration(Biot's

formula):

$$\alpha = [\alpha]_{\lambda}^T \cdot L \cdot C$$

- α [°]: Optical Rotation
 L [dm]: Sample cell length
 C [g/ml]: the concentration of the optically active substance in the solution
 T [°C]: the temperature

When $L=1$, $C=1$, result $\alpha = [\alpha]_{\lambda}^T$, $[\alpha]_{\lambda}^T$ is called the specific optical rotation.

The specific optical rotation $[\alpha]$ is related to the temperature T and the lamp wavelength (λ).

If the optical rotation of a substance were measured under certain light wavelength (λ) and temperature (°C), the sample cell length is L (dm), the specific optical rotation is $[\alpha]_{\lambda}^T$, the concentration of this optically active substance is:

$$C = \alpha / [\alpha]_{\lambda}^T \cdot L$$

If the sample consists of optical and non-optical active substance, the purity of the optical substance could be got through the measured concentration C over the concentration of the prepared sample solution.

(1) Specific Optical Rotation $[\alpha] = 100\alpha / LC$

α is the measured Optical Rotation (°)

C is the concentration of the measured sample (g/100ml). (sample mass/100ml solution)

L is the length of the sample solution (dm)

(2) Purity of the sample: (S.O.P: Specific Optical Rotation)

Purity of the sample = S.O.P(measured)/S.O.P(Theory)

(3) Definition of the International Sugar Scale (ISS-26):

The ICUMSA (International Commission for Uniform Methods of Sugar Analysis) expressed optical rotation in $^{\circ}Z$ on the International Sugar Scale.

The normal sugar solution is defined as 26.0g of pure sucrose weighed in the air and dissolved in the pure water at 20°C to a final volume of 100ml. the optical rotation for the 100 $^{\circ}Z$ is +34.626° at 589.44nm wavelength, in a 200mm sample cell.

3.2 Main parts of the instrument and their function



Fig 3.1 front view of the instrument

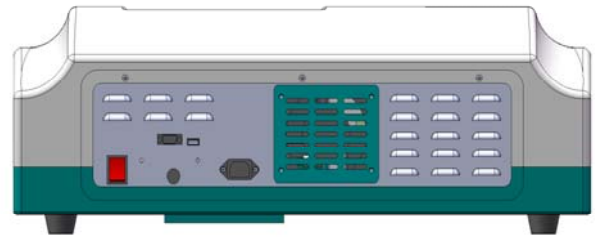


Fig 3.2 rear view of the instrument



Fig 3.3 bottom of the instrument

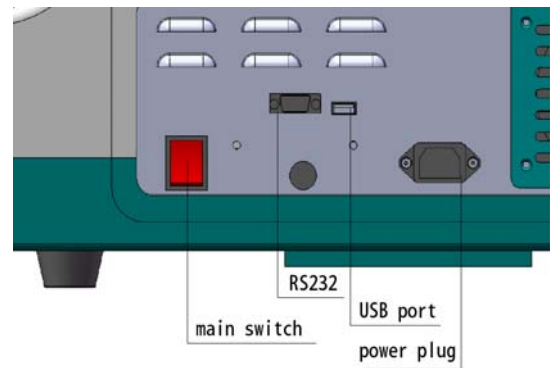


Fig 3.2.1 Functional parts on the back panel

The instrument's power plug, main switch and various external ports are distributed in the back panel of the instrument(Fig3.2.1). There should be enough space(at least 20cm) between the instrument and the wall for main switch easy accessible. And ensure that the cooling air flow through rear of the instrument is not blocked by any obstacles.

The main screen display is in Fig 3.4

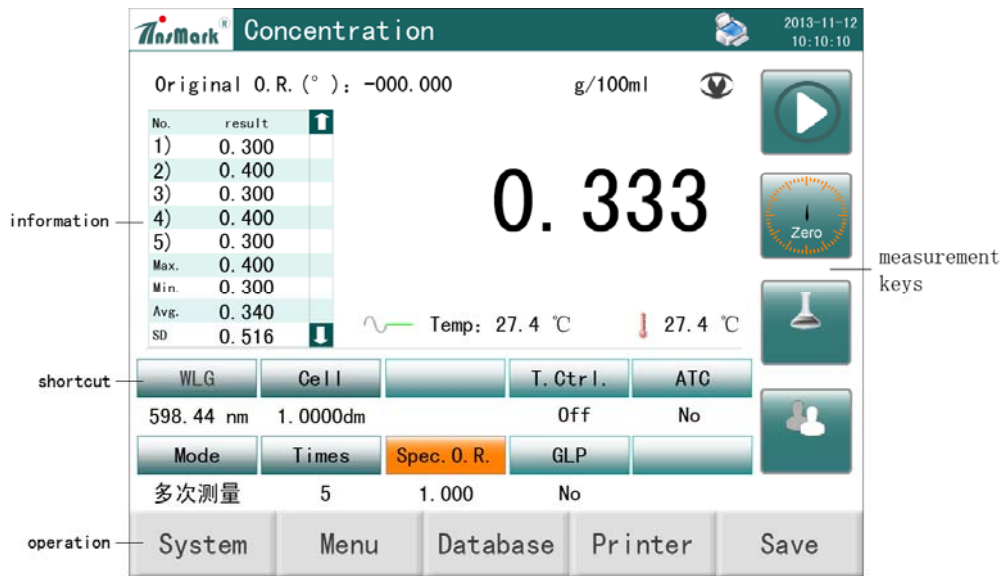


Fig 3.4 Illustration of main measurement screen

3.3 Icons explanation on main screen








Measurement keys:

	Measuring key, press this key to start a new measurement.
	Zero reference key. For zero point adjustment.
	Sample ID, press this key to input Sample ID and the sample ID will be displayed on this key.
	User ID, press this key to input User ID and the user ID will be displayed on this key.

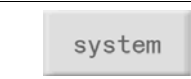



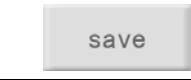
Information area:

	This is the end point icon. When this symbol appears, indicating that the measurement is completed.
	This is an alarm symbol. When this symbol is red, indicating that the sample's transmittance reaches the instrument measurement limits, the measurement result couldn't be accurately.
20.01 °C	Temperature. This temperature is for the latest measurement result.
Temp.	This is the actual temperature in the sample chamber.



Quick access keys area*:

	Sample Cell Length Key. To input the actual length of the Sample cell in dm unit.
	Measurement Mode Key. For sample's single or multiple measurement choice.
	Measurement Times Key. For multiple measurement mode, to change the number of measurements.
	Temperature Control Key. To switch on the temperature control system and set the temperature conditions.
	Auto Temperature Compensation key. To enable or disable this function and key in related elements.
	GLP- Good Laboratory Practice. If this function is on, the sample's ID and User's ID must be input before taking sample measurement.
	To input the sample's Specific O.R. This is for user to measure a sample's concentration.

Operation Keys area:

	This key is for the instrument parameters setting. Details refer to Chapter 4.
	This key is for measurement methods and related parameters settings. Details refer to Chapter 5.
	This key is for database review and export data. Details refer to Chapter 7.
	This key is to print the measurement data to printer. Details refer to Chapter 4.
	This key is for saving measurement data to database.

Printer and Data output sign:

	If the user chooses to print the measurement data, this icon will be displayed on the navigation bar.
	If the user chooses to export the measurement data to the Personal Computer, this icon will be shown in the navigation bar.

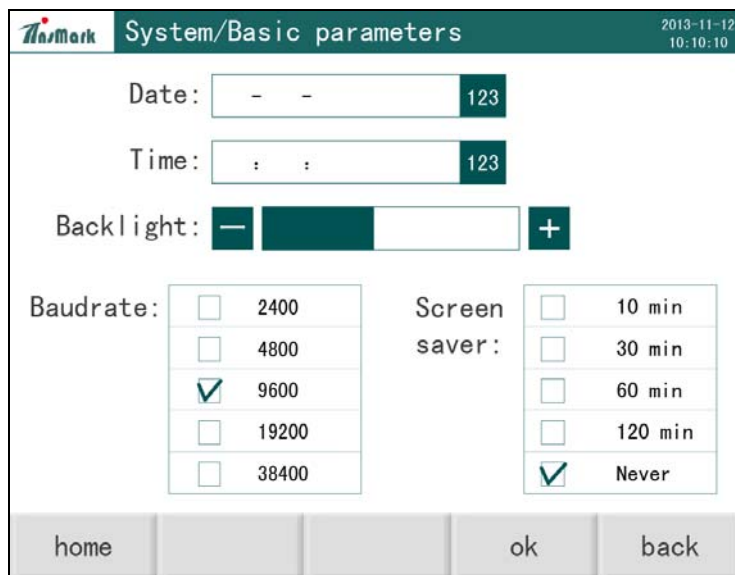
3.4 Operation keys

Home	Back to the main measurement screen
Ok	Confirm modify, back to the previous page
Back	Keep the original settings, back to the previous page

4. System setting

4.1 Instrument basic parameters

Instrument basic parameters including: date, time setting; screen saver setting and baud rate selection. See Fig. 4.1:



The screenshot shows the 'System/Basic parameters' menu. At the top left is the 'TheMark' logo, and at the top right is the date '2013-11-12' and time '10:10:10'. The menu contains the following settings:

- Date: A field with two dashes and a '123' button.
- Time: A field with two colons and a '123' button.
- Backlight: A slider with minus and plus buttons.
- Baudrate: A list of options: 2400, 4800, 9600 (checked), 19200, 38400.
- Screen saver: A list of options: 10 min, 30 min, 60 min, 120 min, Never (checked).

At the bottom are four buttons: 'home', 'ok', 'back', and an unlabeled button.

Fig 4.1 Instrument basic parameters setting illustration

- 1) Press the number key to modify the date or time to match the local date and time.
- 2) The user can select different screen saver time.
- 3) Baud rate selection should be the same one as the current connected computer. This is for the data transmission.

After finish all the modification, press 'OK' to confirm the modified parameters and go back to previous page. Press 'back' key will go back to previous page without saving any modified parameters. Press 'home' key will go back to the main screen. The 'ok' key must be pressed after modifying any parameters.

4.2 Instrument basic information

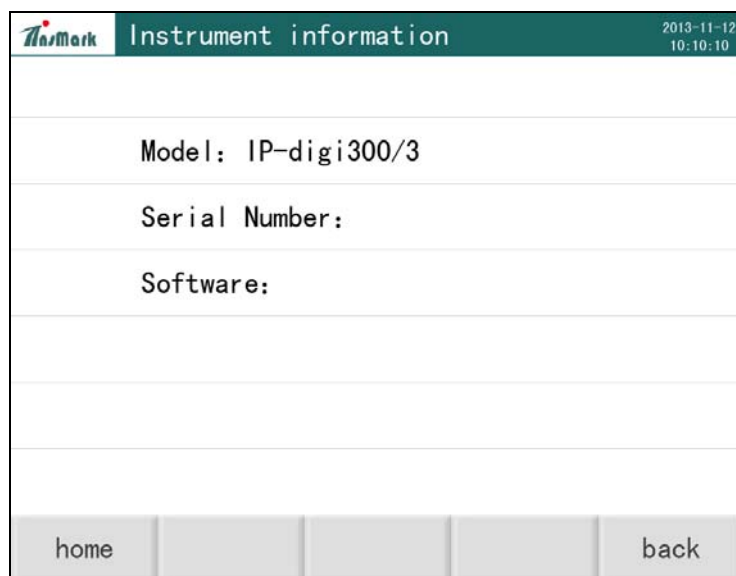


Fig 4.2 Instrument basic information illustration

4.3 Data output setting

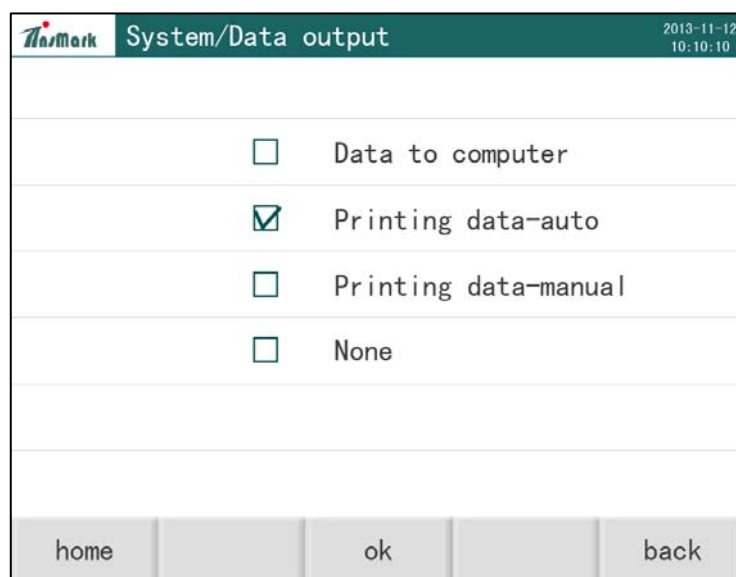


Fig4.3 Data output setting illustration

Under system/data out:

- 1) Data to computer: this function is for the user to output measurement data to the connected computer. (The computer should preload digi-link software from www.insmark.com.cn)
- 2) Printing data-auto: after each measurement, the measurement data will be printed out

automatically via the connected printer.

- 3) Printing data-manual: after each measurement, the user should press the printer button on the main screen to print the measurement data via the connect printer.
- 4) None: none of the above mentioned functions will be enable.

4.4 Restore factory settings



Fig4.4 Restore factory settings illustration

Menu	Factory setting	Menu	Factory setting
Backlight	Brightness	Sample Cell Length	1dm
Baudrate	9600 (bps)	Temp Ctrl.	off
Screensaver	Never	Temp. Setting	20°C
Measurement Mode	Single	Stable Temp	0.5°C
Measurement times for multiple meas. mode	6	Stable time	60s
Interval time for continuous meas. mode	5s	User ID	Blank
Measurement Method	Optical Rotation	Sample ID	Blank
GLP	Off	ATC	No

5. Measuring Menu

On main measurement screen, press 'menu' key to the interface for the measurement selection, Fig. 5.1

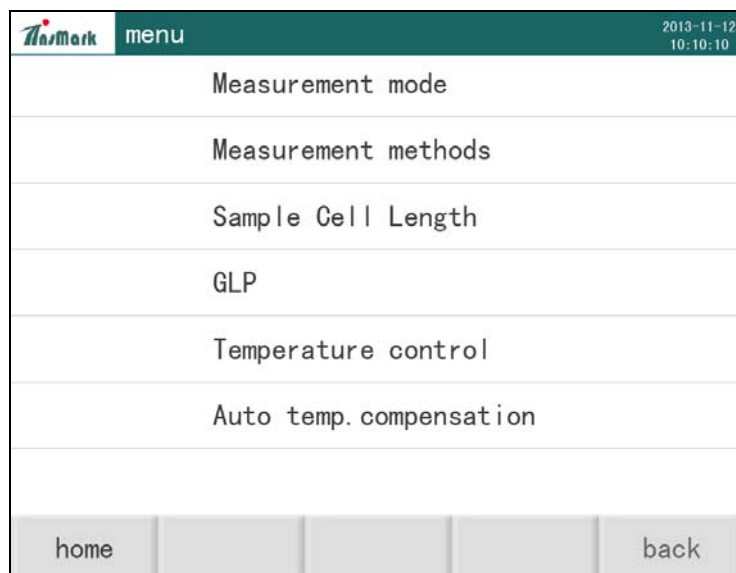


Fig5.1 Measuring menu illustration

5.1 Measurement mode

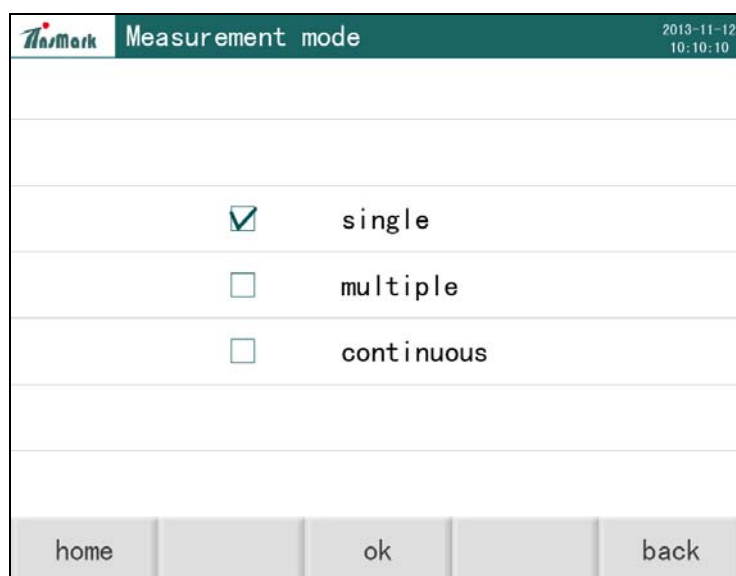


Fig 5.2 Measurement mode selection

This is for one sample measurement. Single: measure the sample once. Multiple:

measure sample 2-10 times at a measurement(statistic). Continuous: measure a sample at a certain time period.

The user can press quick access key 'mode' on the main screen to make a choice. Press 'times' key to change the measurement times. All the measurement data will be displayed on the information area including the Max, Min, AVG, and Standard deviation values.

For the continuous measurement selection, first of all the user should connect the computer to the instrument, open the Digi-link software on the computer. Then select transfer 'data to computer' under system/data output, select the same baud rate as the connected computer's, select the time interval for data transmission, the measurement data will be automatically transferred to the computer and be saved for further analysis.

5.2 Measurement methods

There are 4 measurement methods for user to choose:

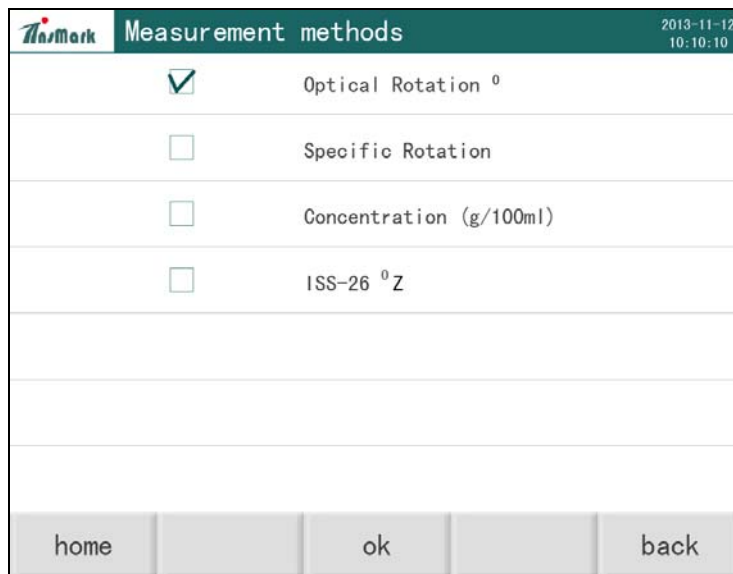


Fig 5.3 Interface of Measurement methods choices

- Sample's Concentration and Specific Optical Rotation are based on Biot's Law. User should input sample Specific Optical Rotation or Concentration accordingly if these methods are chosen.
- <ISS-26> is the International Sugar Scale, refer 3.1 for more details.

5.3 Sample Cell Length

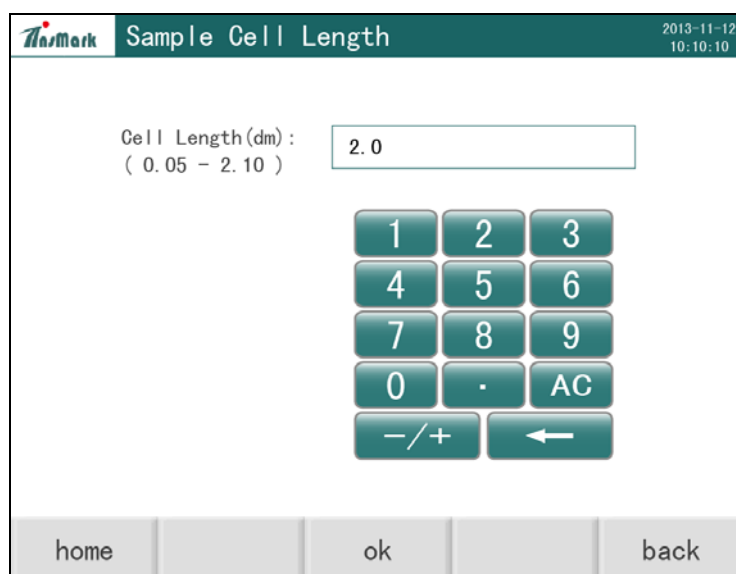


Fig 5.4 Illustration of the Sample Cell Length input

Users should input the sample cell length according their usage. The length unit is dm. The range is: 0.1dm ~ 2.0 dm.

5.4 GLP-Good Laboratory Practice

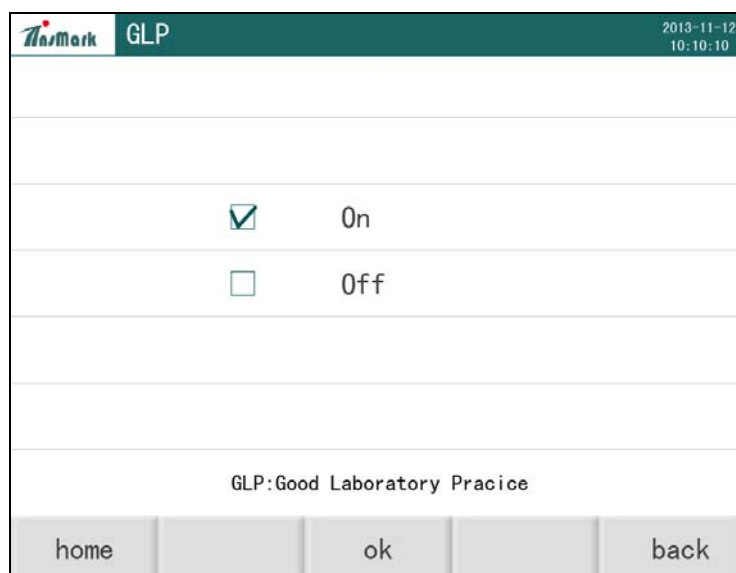


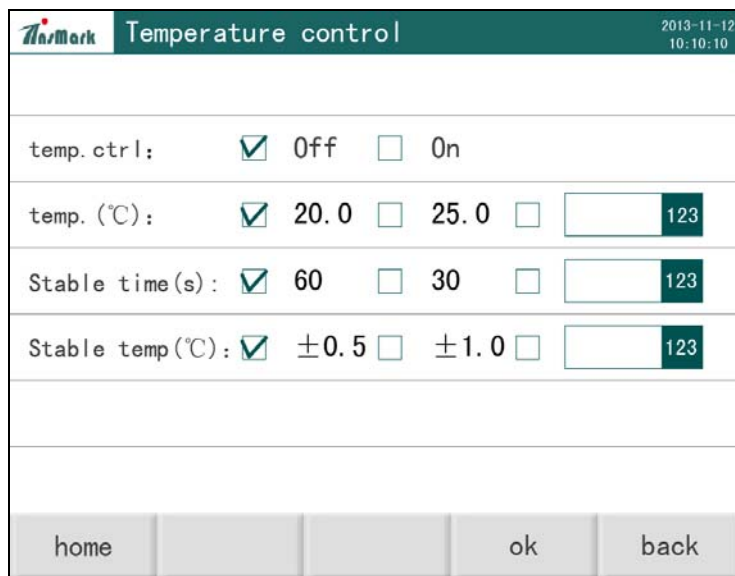
Fig 5.5 GLP function illustration

GLP is for Good Laboratory Practice, according to the international standards “all the

records should be timely, directly, accurately, clearly and should not be eliminate. The records should come with date, time, operator’s signature...”

- 1) IP digi polarimeter provides GLP function. When user enable this function, the instrument will prompt you following the GLP related operation steps, to ensure that your measuring records meet the GLP standards.
- 2) On the main screen, press GLP key, select ‘on or off’ to enable this function.
- 3) GLP function is on, all the measured data will be automatically saved to the database.

5.5 Temperature control (IP-digi2/IP-digi8)



TasMark		Temperature control		2013-11-12 10:10:10	
temp. ctrl:	<input checked="" type="checkbox"/> Off	<input type="checkbox"/> On			
temp. (°C):	<input checked="" type="checkbox"/> 20.0	<input type="checkbox"/> 25.0			123
Stable time(s):	<input checked="" type="checkbox"/> 60	<input type="checkbox"/> 30			123
Stable temp(°C):	<input checked="" type="checkbox"/> ±0.5	<input type="checkbox"/> ±1.0			123
home ok back					

Fig 5.6 Illustration of Temp control setting

- 1) Switch ‘on/off’ the temperature control system.
 - 2) Temperature: set the specific temperature.
 - 3) Set the stable time.^a
 - 4) Set the stable temperature/temperature deviation.^b
- a. Stable time:
- Stable time is the time length of which the Temperature Deviation(TD) meets the setting TD value. In this continuous time period, the temperature deviation must be always within the value range. Once the actual deviation value is out of the limit, the time count will stop. This time will be counted again after the condition reaches. The

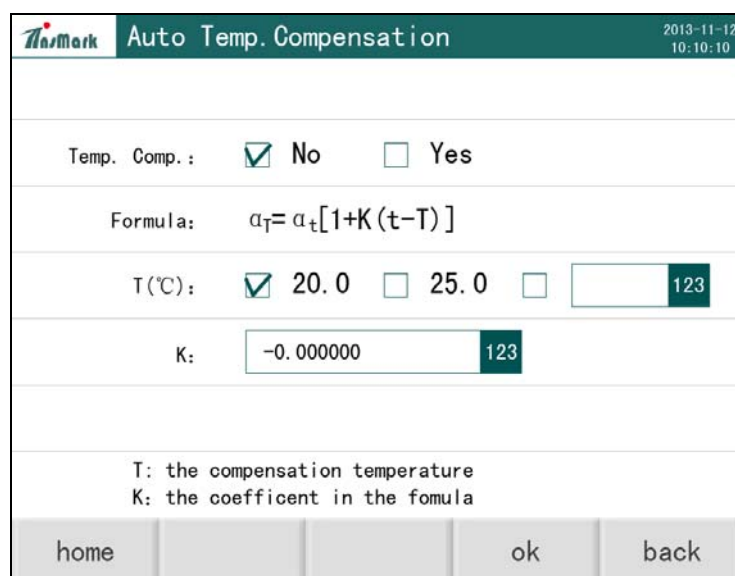
factory default value is 60 seconds.

b. Stable temperature:

Stable temperature/Temperature deviation(TD) is the difference between the present sample tube temperature and the instrument setting temperature. Only when the actual TD is less than the setting one, the instrument system will consider it's satisfying the setting conditions. The factory default value is 0.5⁰C.

5.6 Temperature compensation

If the sample is measured at room temperature, the measured value could be compensated to a specific temperature, e.g. 20⁰C, via the temperature compensation formula, a compensation coefficient is needed. Fig5.7



InMark		Auto Temp. Compensation		2013-11-12 10:10:10	
Temp. Comp. :	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes			
Formula:	$\alpha_T = \alpha_t [1 + K(t - T)]$				
T(°C):	<input checked="" type="checkbox"/> 20.0	<input type="checkbox"/> 25.0	<input type="checkbox"/>	<input type="text" value="123"/>	
K:	<input type="text" value="-0.000000"/>	<input type="text" value="123"/>			
T: the compensation temperature K: the coefficient in the fomula					
home			ok	back	

Fig 5.7 Interface of ATC settings

Press 'ATC' key on the main screen, select 'Yes', 'compensation temperature T', input the coefficient of the formula 'K', press 'ok' to save the changed settings.

6. Measurement

6.1 Instrument warm-up time

To ensure the accuracy of the measurement, the instrument should be switched on at least half an hour before taking any sample measurement.

6.2 Choose a measurement method

Four methods are listed in the menu: Optical Rotation(default method), Specific Rotation, Concentration(Biot's law), International Sugar Scale(ISS-26)

6.2.1. Measurement methods quick access


On the main screen, press the <Optical rotation> on the navigation bar, the user can select the measurement methods. Back to the main screen, the user can modify the measurement conditions according the selected method. Refer to 5.2 for more details.

6.2.2. Measurement methods under MENU

Press MENU to select the measurement method.


6.3 Zero point reference



Setting zero point is recommended for each measurement taking.

Fill up the sample cell with DI water or blank solvent which will be used in the sample solution. Avoid any air bubble/solid particles in the light path. Dry the both end of the sample cell with a soft tissue. Don't screws the sample cell end too tight which might cause stress and affect the readings. Pay attention to the direction and position of the sample cell when place it into the sample chamber. Close the chamber cover, press  key. The new date, time will be displayed on the zero point key after the setting.

6.4 Measurement

6.4.1. Sample measurement-without temperature control


Fill up the sample cell with the sample solution, put it back to the sample chamber, close the chamber cover, press  key to measure the sample. When place the sample cell onto the sample holder, same position and direction are needed.

when  appears, indicating that the instrument is performing data processing, when  appears, the final result is locked.

6.4.2. Sample measurement-with temperature control

If a sample needs to be measured at a specific temperature, a thermo polarimeter sample

cell is needed. Please refer 5.5 to switch on the temperature control system, set the specific temperature and the stable conditions, press ‘ok’ key to confirm the modification of the conditions.

Fill up the thermo polarimeter sample cell with DI water or blank solven used in the sample solution, place it in the sample chamber. The heat transfer surface of the cell should be touched with the sample chamber’s. Connect the temperature sensor to the sample chamber. Close the chamber cover. If the sample’s temperature is not at the setting temperature, the measurement key and zero point key on the main screen are not working. Press  key to adjust the zero point after the sample cell temperature reaches the setting point.

Fill the sample solution into the same thermo polarimeter sample cell. Place it back to the sample chamber according the operation metioned above, close the chamber cover, waiting for the sample temperature reaching the setting temperature again. Press the measurement key to take a measurement.

Switch off the temperature control after taking the sample measurement via the main screen/T. control./ select off the temperature control system.

6.5 Switch off the instrument

Please swith off the instrument after usage. switch off the main power supply.

7. Database

On the main screen, press “database”, the user can check his measurement data saved in the database. Fig 7.1:

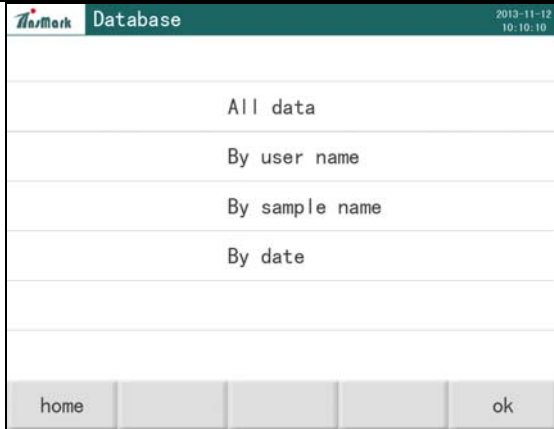


Fig7.1 Illustration of the database

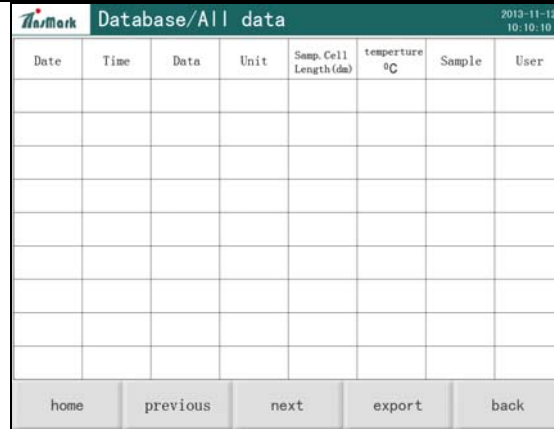


Fig7.2 Display contents of the Database

- 1) Press “all data”, the user can view all the measurement data saved in the database
- 2) Press “previous” or “next” to view the data in previous or next page, Fig 7.2.
- 3) The user can press the datum for more details of the selected datum.
- 4) Connect the USB disk , press the export key, all the data in the database will be exported to U disk.

U disk export function:

Following Fig7.2, press the “export” key, all the data will be exported to U disk. Make sure that USB disk to be connected to the instrument before exporting data. Enter file name then tap “OK” to export data.

The user can select “whether to delete all records?” if data export successful.

The exported file format is .csv. This format file is supported by Microsoft Excel.

About the Database:

Database has a limitation space for data saving. If the database is full, the user should export data regularly to release space for new data saving.

- 1) GLP function is OFF: the measurement data are saved manually. If the database is full, press “save” button, the oldest datum will be replaced by the new datum.
- 2) GLP function is ON: the measurement data are saved automatically. If the database is full, the instrument will remind the user to export data before taking any sample measurement.

Details of each datum:

All the information related to each measurement datum has been saved in the database, the user just press each datum to view the details. Fig. 7.3.

8. Technical Data

Data \ Model		IP-digi1	IP-digi2	IP-digi7	IP-digi8
Measuring Range	°OR	±90°	±90°	±90°	±90°
Resolution	°OR	0.001°	0.001°	0.001°	0.001°
Accuracy	°OR	±0.01°		±0.004°	
Reproducibility	°OR	0.002°		0.001°	
Prism		Polaroid		Glan Thompson	
Sensitivity		0.5%		0.1%	0.01%
T.control mode		--	Peltier	--	Peltier
T.control range		--	10°C~50°C	--	10°C~50°C
T.control accuracy		--	±0.2°C	--	±0.1°C
Temp. Meas. Range		0-100°C			
Temperature resolution		0.1°C			
Data output		USB, RS232			
Power		220V±22V, 50Hz±1Hz, 250W			
Dimensions(L*W*H)		720mm×365mm×240mm			
Weight		28 kg	30kg	28 kg	32kg
Meas Methods		Optical rotation; Specific rotation; Concentration; International sugar scale			
Light source		LED light source			
Wavelength		589.44nm			
Display		8" touch screen, color LCD			
Storage Temperature		-25~40°C			



* The red eye icon indicates that the sample's sensitivity is lower than 0.5%. The measurement result is not accuracy. The user should dilute the sample or use a shorter length sample cell to measure the same sample again.

9. Maintenance

IP-digi series polarimeter is the instrument with high precision. Please pay attention to the maintenance.

- The instrument should be stored in a dry and cool place.
- Don't let the LCD screen exposed under directly sunlight for a long time.
- Clean the sample tube thoroughly before and after loading samples.
- Wipe the instrument with soft cloth.
- Cover the instrument properly when it is not been used for a long time .
- The instrument is only be checked and repaired by authorized engineer.
- Avoid haze, dust and solvent gas environment from the instrument.

10. Help

The polarimeter is a instrument with high precision. To ensure a high accuracy of sample measurements, please pay attention to the followings:

- Switch on the instrument for at least half an hour before taking any measurement.
- Remove any air bubbles or particles in the sample cell and always keep the same position and direction when placing the sample cell in the sample holder.
- Rinse the sample cell thoroughly.
- Keep the sample temperature consistent with room temperature before taking measurement. Please use the special sample cell when you switch on the temperature control function.
- Dark sample: dilute the sample before taking measurement or use a shorter length sample cell.
- Calibration: if user wants to calibrate the instrument, please use the super A-Box supplied.