Ferrous Debris Monitor

LMFDM-A100

Index

1. Safety Measures

1.1 Instrument storage

- Avoid placing the instrument in strong magnetic areas.
- Do not place the instrument in places with strong sunlight or heat radiation (such as heaters).

1.2 Instrument use

- The same type of equipment cannot be placed within 1.5 meters, and do not use mobile phones within 2 meters.
- Do not run on metal countertops or metal shelves.
- The instrument should be kept level. A little inclination will not affect the accuracy of the measurement. If the inclination is too large, the measurement accuracy will be reduced. The inclination can be judged by observing the level bubble on the upper left side of the instrument.
- During the operation of the instrument, the environment should not have vibration, and there should be no airflow passing through the instrument.
- The instrument's surface should be kept clean, especially to avoid metal particles near the sensor.
- The oil sample bottle should be kept clean to avoid the adhesion of metal particles.

2. Introduction

Ferrous Debris Monitor LMFDM-A100 offers a swift and straightforward analytical method to detect ferromagnetic wear particles within lubricants. It utilizes the PQ index ranging from 0 to 15000 in conjunction with elemental analysis to enhance the efficiency of fault detection. Its real-time monitoring processes enable the easy visualization of detection results.

3. Features

- Features an integrated human-computer interaction interface
- Offers real-time display for precise, instant feedback
- Ensures efficient and accurate measurement of the PQ index
- Incorporates improved mechanisms for detecting device faults
- Allows customization of measurement settings and detection methods
- Default settings enable rapid detection of oil samples without extensive adjustments
- Capable of self-calibration, ensuring consistent and reliable performance
- Designed for ease of use, providing high sensitivity while maintaining user-friendliness
- Delivers test results swiftly, within a mere 10-second timeframe

4. Specifications

Model No.	LMFDM-A100
Detection Range	0 to 15000 PQ
Particle Range	> 1μm
Ambient Temperature	15 ℃ to 30 ℃
Working Environment Humidity	30% to 80%
Power Connection	IEC 6A 3PIN power cord
USB Connection	Type-A2.0 (only for connecting USB flash disk)
Data Communication	RS232 serial communication port
Measurement Resolution	1PQ (average resolution 0.1PQ)
Repeatability	±0.5% or ±3PQ
Turntable Speed	11 S / turn
Display	5.6 inches TFT color LCD display
Power Supply	AC 100V to 240V 50Hz /60Hz
Power Consumption	< 15 W
Dimensions	402 × 266 × 186 mm
Weight	<5 kg

5. Applications

It is utilized in oil analysis laboratories, as well as industries such as wind energy, power generation, aerospace, and military, for detecting debris and wear particles.

6. Instrument Introduction

Figure-1 Rear View

Figure-2 Front view

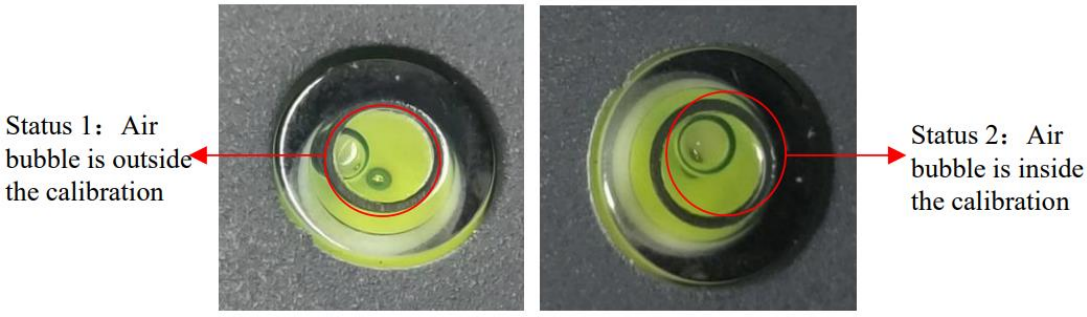

Figure-3 Instrument horizontal bubble

Note: Ensure the horizontal bubble is inside the calibration circle.

Names and functions of the parts corresponding to each part

No.	Part Name	Function
1	Turntable	Send oil samples to the detection area for measurement
2	USB port	USB flash disk insertion interface
3	Data output	For exporting measurement data
4	Power	AC power port
5	Measuring hole	Place oil samples to do measurement
6	Instrument level bubble	Instrument horizontal status indication
7	Conversion ring	Fixed oil sample container
8	Power switch	Power on/off

7. Installation

Installation steps:

1) First, take out the main unit, connect it to the power supply and switch it on (as shown in **Figure 4**), then install the turntable and nut on the main unit and fix them with screws (as shown in **Figure 5**). Click **"System Settings"** to enter the interface **(Figure 6).**

Figure-4

Figure-5

2) Click "**Turntable reset**", the turntable starts to rotate and stops after rotation. Confirm whether the scale on the turntable and the scale on the host are aligned. If it is not aligned, you need to manually adjust the rotating disc scale to align with the host scale, click **"turntable reset"** again until the scale is aligned with the host scale (**Figure 7**), and finally tighten the screws and cover the cap **(Figure 8)**.

Figure-6

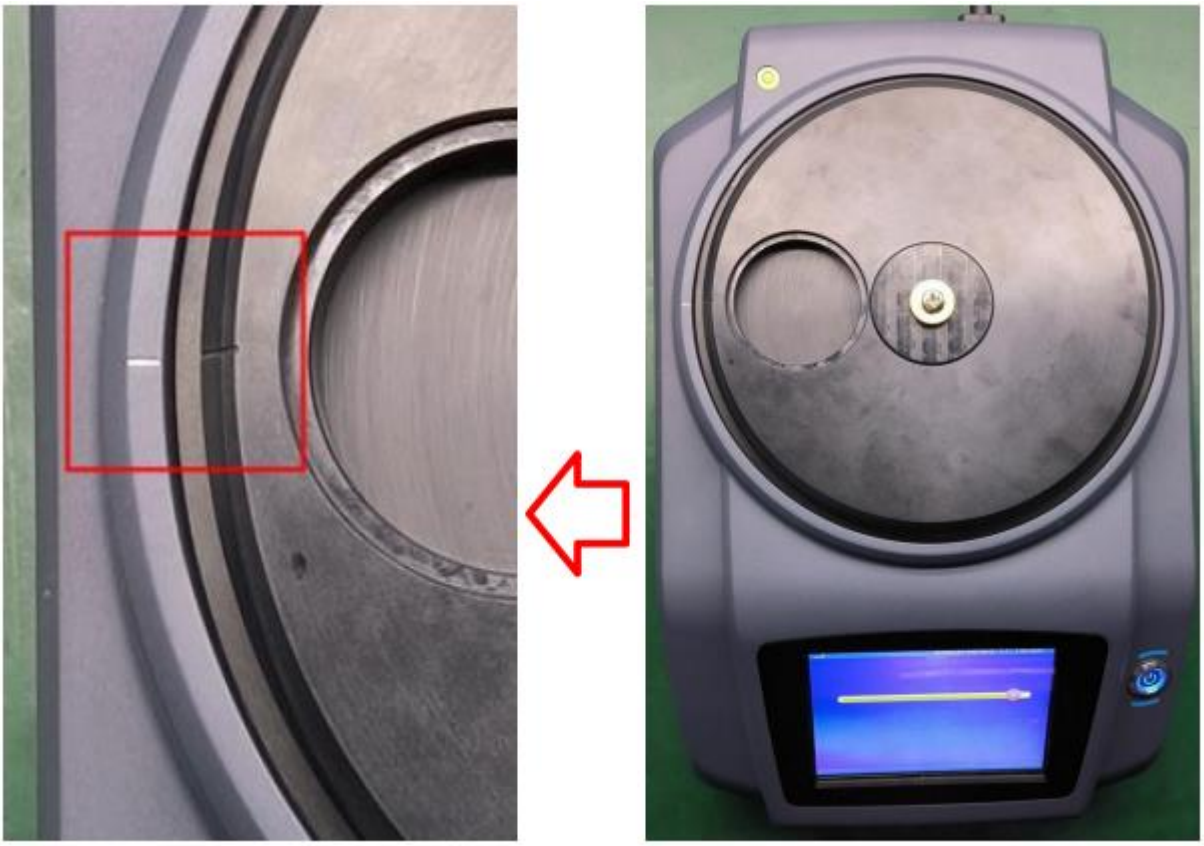

Figure-7

Figure-8

8. Software Operations

8.1 Startup

8.1.1 Power connection

Connect the instrument to the power supply (AC 100V~240V), and turn on the power switch, the instrument will display the LOGO, and the screen will enter the main interface of the system after a few seconds (as shown in **Figure 9**). At the same time, the turntable will automatically find the zero position.

Figure-9 System main interface

8.1.2 System Warm-up

The instrument is turned on and left for more than 10 minutes, and the instrument is warmed up before calibration and measurement can be performed.

8.2 Calibration

It is recommended to calibrate regularly according to the actual situation. Calibration steps are as follows:

1) On the main interface, click **"Calibration"** to enter the calibration interface (as shown in **Figure 10**)

Figure-10 Calibration interface

2) In the calibration interface, click "**Start Calibration**", and the screen will pop up "Put 0PQ standard sample, and then press **OK**" (as shown in **Figure 11**).

Figure-11 "OK" prompt box

3) Internal measurement voltage conversion value of 0PQ 4 times continuously. After the measurement is completed, the screen prompts "Put the 750PQ standard sample, and then press OK" (as shown in **Figure 12).**

Figure-12 750 standard oil sample calibration interface

4) According to the calibration interface (as shown in **Figure 12**), put the 750PQ standard oil sample into the measuring hole on the turntable, click "**OK**", and the instrument reads the internal measurement voltage conversion value of the 750PQ standard oil sample for 4 times (as shown in **Figure 13**). Save the calibration result, click "**Save**", and the calibration data will be saved in the system memory. Exit the calibration interface, click **return** " ", and the screen will return to the main interface. If you do not need to save the calibration data, click " " to return to the main interface.

Figure-13 Shows the signal value of the standard sample

Notes:

1) In the calibration completion interface, the 4 sets of values on the left are the signal values of the sensor in the state of no oil sample; the 4 sets of values on the right are the signal values of the sensor under the 750PQ standard oil sample.
2) After the calibration of the instrument, if the measurement of the 750PQ standard sample exceeds the error range (±1%), it is recommended to re-calibrate.
3) If repeated calibrations still exceed the error range, there may be a malfunction inside the instrument.

8.3 Measurement

8.3.1 Sampling of oil to be tested

Preparation before measurement: First prepare a container of suitable size, and then take the oil samples to be tested into the container. Put the conversion ring in the measuring hole of the turntable, use the sampler to take 2ml of oil from the container and put it into the standard oil sample box, cover the oil sample box tightly and put it into the conversion ring, and the sampling is ready.

Note: For keeping the accuracy of measurement, a pretreatment process must be carried out for the oil to be tested before measurement:

1) Before sampling from the container, thoroughly mix the oil and ferrous abrasive particles in the container. You can shake it by hand or use a vibrator to fully mix the oil and ferrous abrasives in the container, and then quickly use a sampler to sample the oil in the container.
2) After the oil is taken into the oil sample box, the large-diameter ferrous abrasive particles in the oil sample box sink to the bottom quickly, and the very tiny abrasive particles are still in a state of uniform mixing. As time goes by, the tiny abrasive particles will slowly sink into the oil sample bottom of the box. The more ferrous abrasive particles are deposited on the bottom, the greater the PQ value measured by the instrument will be. To ensure the consistency and stability of the PQ value, the oil box to be tested needs to be left for some time after sampling and then measured after most of the ferrous abrasive particles sink to the bottom.
3) **Figure 14** shows the measurement results of a 2ml oil sample mixed with tiny ferrous particles (<5um) on this instrument, which is measured every 1 minute and continuously measured for 1 hour (60 times).

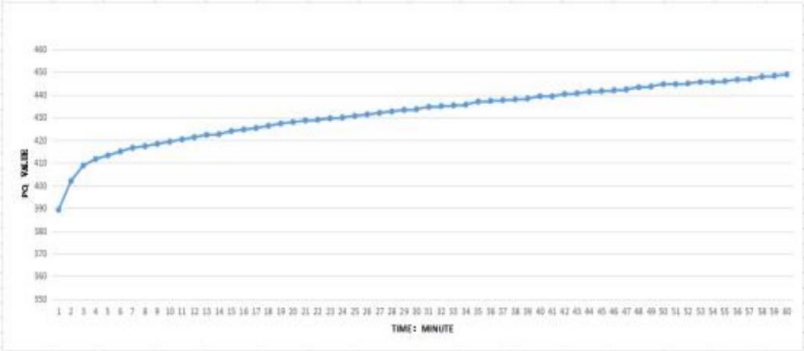

Figure-14 PQ value-time curves at different times

8.3.2 Enter the measurement setting interface

On the main interface, click **"Measurement"** to enter the measurement setting page (as shown in **Figure 15**). You can set the file name, measurement times, and alarm upper limit value for saving this measurement. Select the new measurement mode and superimposed measurement mode (the difference between the two saved files needs to be explained).

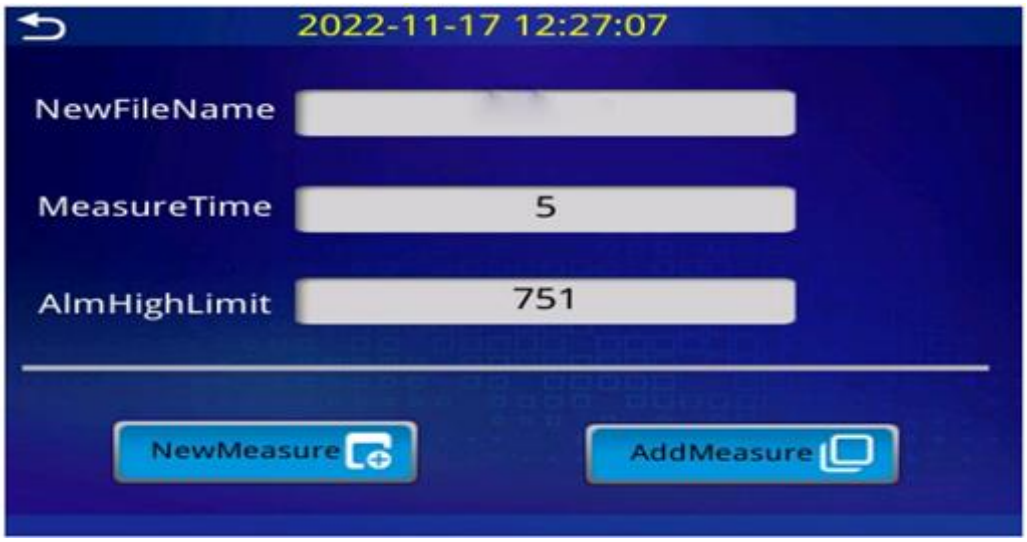

Figure-15 Measurement settings

8.3.2.1 Set file name

Click the text display window of the setting file, and the input keyboard will automatically pop up on the screen (as shown in **Figure 16**).

Figure-16 Keyboard input interface

Enter the file name with the number and letter keys.
Shift key: Switch letter case.
Del key: Delete a character entered.

Confirm key: Confirm the input file name characters and close the keyboard.

Close key: Close the keyboard directly without modifying the characters of the file name.

8.3.2.2 Set the measurement times

The measurements times refers to the total number of tests when measuring a sample, and the test result of the sample is the average value of the number of tests. Click the text display window of the measurement test on the screen, and a number input keyboard will pop up on the screen. The input range of the number of tests is 1-100 (as shown in **Figure 17**).

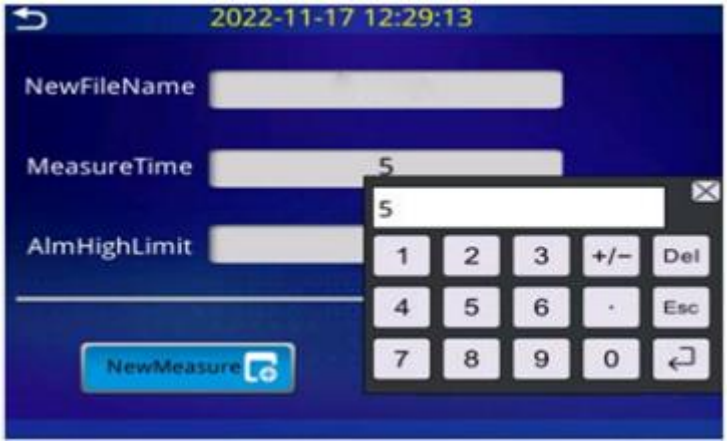

Figure-17 Input of test times

8.3.2.3 Set the alarm limit

The significance of setting the alarm value is that when the measurement result exceeds the alarm value, the data points on the measurement curve will turn red, and the data points that do not exceed the alarm value are normally green. When the average value exceeds the upper limit of the alarm, its display color will turn red to remind the measurement personnel to pay attention. Click the alarm upper limit value input box, and a numeric keyboard will pop up on the screen, and you can directly use the keyboard to input numbers. The upper limit alarm value input range is 1-15000.

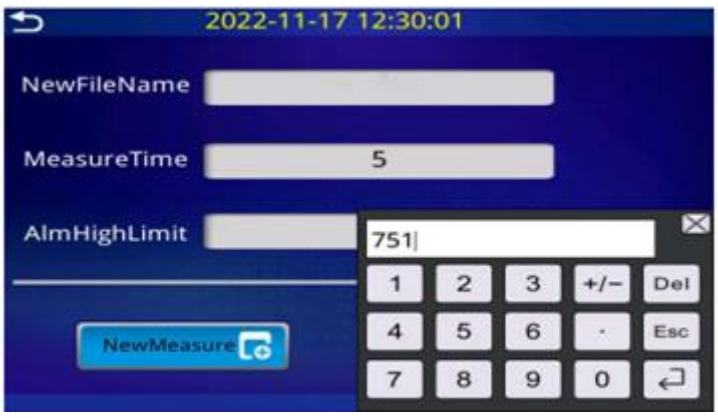

Figure-18 Alarm limit setting

8.3.2.4 New measurement

After all the settings are completed, press the **"New Measurement"** button at the bottom of the screen, and the system will enter the measurement page (as shown in **Figure 19**).

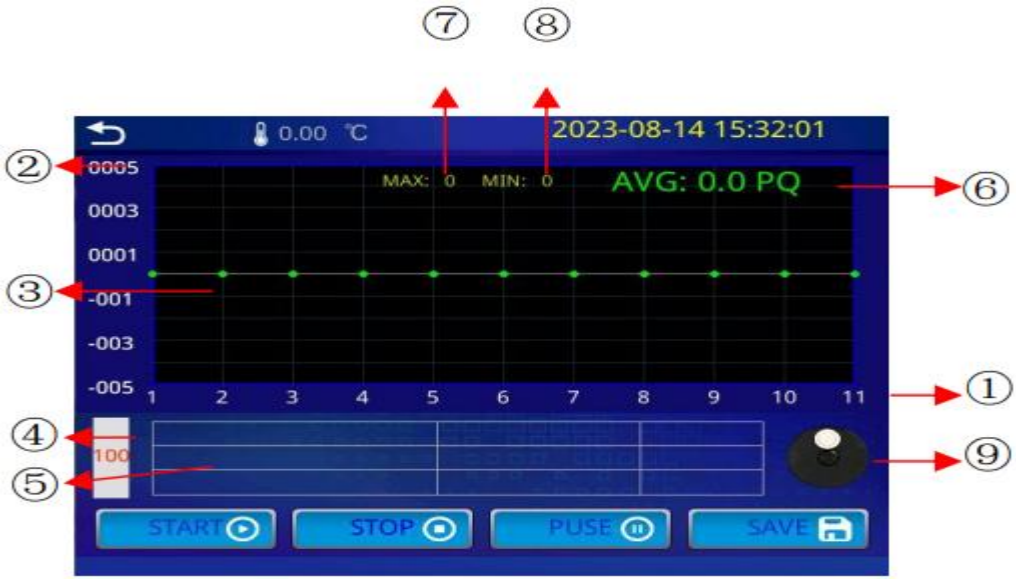

Figure-19 Measurement page

Press the **"Start"** button, and the system will automatically measure according to the set number of measurements. Every time a measurement is made, a data point will be displayed on the graph, and the progress bar of the number of measurements will also be automatically decremented to display the current remaining number of measurements. When the actual number of measurements is equal to the set number of measurements, the measurement is completed, the progress bar of the number of measurements shows 0, and the instrument automatically beeps to remind the measurement personnel to pay attention. The top of the graph shows the statistics of the measurement results, the maximum value of the data MAX, the minimum value MIN, the average value AVG, and the average value is the result of this measurement.

The function description of each serial number on the measurement page in **Figure 14** is as follows:

Number	Name	Function Description
1	X axis	Indicates the sampling point
2	Y axis	Indicates the PQ measurement
3	PQ value	Time graph
4	Progress bar	Number of remaining measurement
5	Measurement record sheet	The first column is the measurement recording time
		The second column is the sampling point
		The third column is the PQ value
6	AVG	Indicates the average measured value

7	MAX	Indicates the maximum measured value
8	MIN	Indicates the minimum measured value
9	Turntable indicator	Synchronized with the turntable running in the actual process

Press the **"Start"** button, and the system will automatically measure according to the set number of measurements. Every time a measurement is made, a data point will be displayed on the graph, and the progress bar of the number of measurements will also be automatically decremented to display the current remaining number of measurements. When the actual number of measurements is equal to the set number of measurements, the measurement is completed, the progress bar of the number of measurements shows 0, and the instrument automatically beeps to remind the measurement personnel to pay attention. The top of the graph shows the statistics of the measurement results, the maximum value of the data MAX, the minimum value MIN, the average value AVG, and the average value is the result of this measurement.

Note: The minimum number of sampling points represented by the abscissa displayed on the graph is 5 points, and the maximum number of sampling points is 100 points. When the actual number of sampling points is greater than 100 points, the graph displays the latest 100 points of data. You can click the area on the right side of the graph to move the curve to the right.

Click on the left area of the graph to move the curve to the left as a whole. Click the upper area of the graph to zoom in on the X-axis of the graph (the distance between points on the X-axis becomes larger) and click on the lower area of the graph to shrink the X-axis of the curve (the distance between points on the X-axis becomes smaller).

8.3.2.5 Save

After the measurement, press the "**Save**" button to save the measurement results. Save file names are generated according to the following rules:

When a U disk is plugged into the USB socket at the back of the instrument, the file is stored in the U disk, and the file name is: " D:/measurement file name_year, month, day, hour, minute, second.csv".

When no U disk is inserted, the file is stored in the internal memory of the instrument, and the file name is: " C:/measurement file name_year, month, day, hour, minute, second.csv ".

8.3.2.6 Overlay measurement

8.4 History record

On the main interface, click "**History**" to enter the interface for viewing records (as shown in **Figure 20**).

Figure-20 View record interface

The list box on the left lists the contents of the recorded files. The file name is "C:/...", which means that the current file is stored in the internal memory of the system. When the instrument is inserted into the U disk, the list box will automatically switch to display the stored files in the U disk.

At the same time, the file name is switched to "D:/...", and the USB disk icon " " is displayed on the lower right side of the page, and " " is the switching icon of "internal storage\U disk". Click " " to switch to the internal memory icon " ", and the list box is switched to the files in the system's internal memory. The right side of the interface in **Figure 20** is the file operation icon. There are six operation methods for files: open the file, rename the file, delete the file, delete all, upload a file, and upload all.

Notes: When the files in the U disk are displayed, there are only three operation methods for the files: open the file, rename the file and delete the file.

8.4.1 Open a file

In the view record interface, click the file name to be opened, the background of the selected file name is blue (as shown in **Figure 21**) and click **"Open File"** to enter the historical record browsing interface (as shown in **Figure 23**).

Note: When no file is selected, the interface of clicking "Open File", "Delete File", "Rename File" and "Upload File" will prompt that no file is selected (as shown in **Figure 22**). Click back " ", and the screen will return to the main interface.

Figure-21 File selection

Figure-22 No file selected

8.4.2 Browsing history

The historical record browsing interface can view the saved measurement files in the form of curves. When you click the icon " " to open it, you can pan the curve left and right or zoom the X axis. The operation method is as follows:

1) Click the area on the right side of the graph to move the curve to the right.
2) Click the area on the left side of the graph to move the curve to the left as a whole.
3) Click the X-axis of the curve in the upper area of the graph to zoom in (the distance between the X-axis points and the points becomes larger).
4) Click on the lower area of the graph to zoom out on the X-axis of the curve (the distance between points on the X-axis becomes smaller).

When the icon " " is turned off, the curve cannot be panned left and right, or X-axis zoom operation.

Click a record point on the graph, and the measurement time, file name, and measurement value of the point will be displayed on the top of the screen. (as shown in **Figure 23**).

Figure-23 History browsing interface

8.4.3 Rename file

In the record view interface, select the file to be renamed, click **"Rename file",** and the interface pops up to input the file name, click the file name display box, and the interface pops up the input keyboard, use the keyboard to input the file name, click **"OK"** to enter the valid, click **"Cancel"** to cancel the file name renaming (as shown in **Figure 24**).

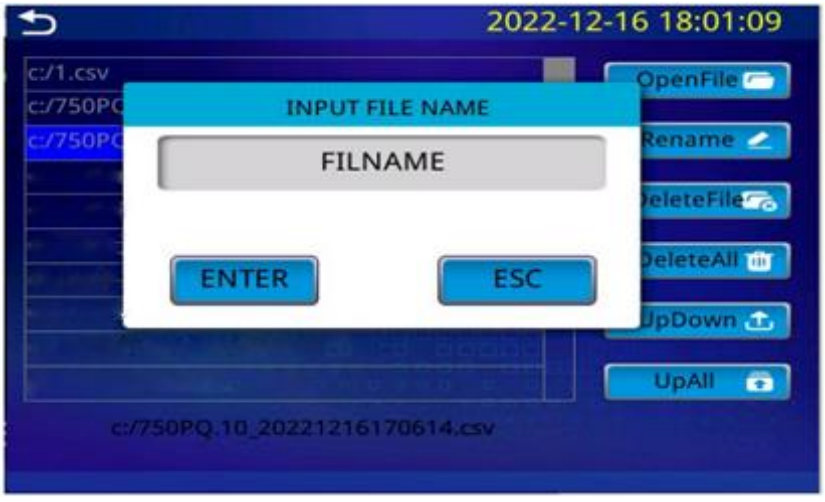

Figure-24 File name change

8.4.4 Delete files

In the view record interface, select the file to be deleted, click "**Delete File**", the interface will pop up "Attention, the file will be deleted", click "**OK**", the selected file will be deleted, click "**Cancel**" to cancel the operation of deleting the file (**Figure 25**).

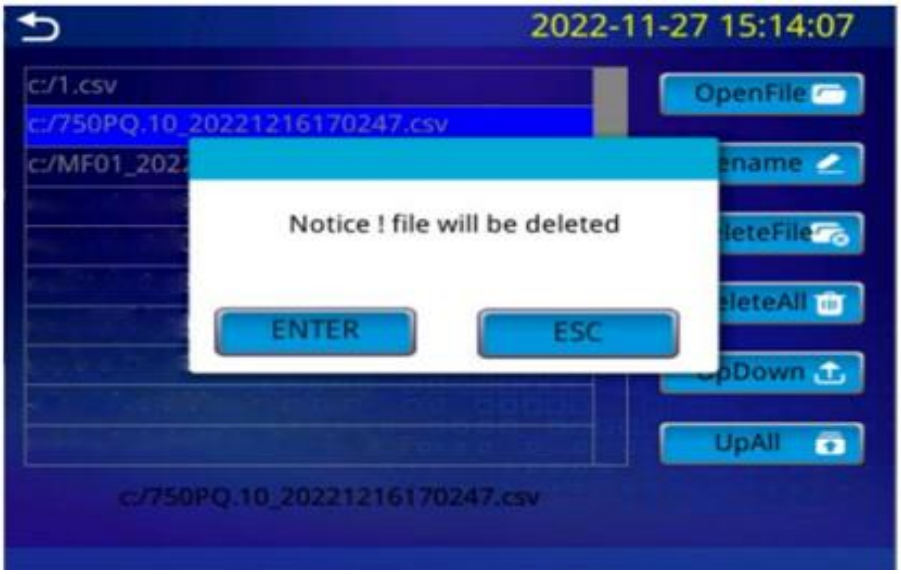

Figure-25 File deletion

8.4.5 Download files

Downloading files refers to copying files stored in the system memory to the U disk, so this operation can only be performed when the U disk is inserted into the instrument. Upload all is to directly copy all the data stored in the system memory to the U disk.

8.5 System settings

On the main interface, click **"System Settings"** to enter the system settings interface (as shown in **Figure 26**).

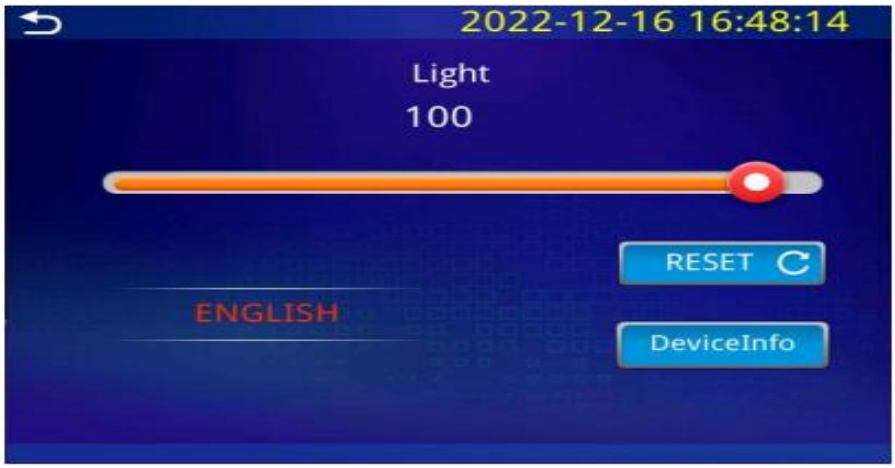

Figure-26 System setting interface

8.5.1 Date and Time setting

In the system setting interface, click the time display area, and the date and time modification keypad will pop up on the interface (as shown in **Figure 27**). Use the small keyboard to enter the year, month, day, hour, minute, and second, click the "  " on the small keyboard to exit, and the date and time modification is completed (as shown in **Figure 28**).

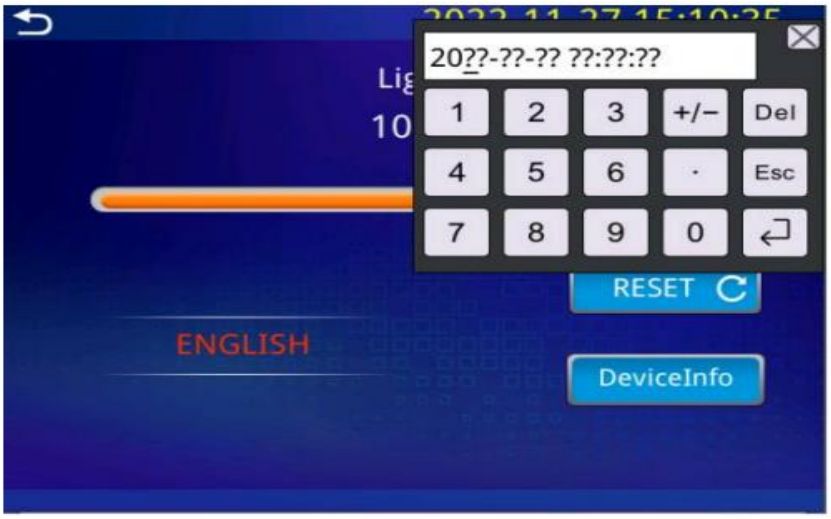

Figure-27 Date setting

Figure-28 Time setting

8.5.2 View device information

On the system setting interface, click **"Device Information",** and the interface pops up the device information window (as shown in **Figure 29**).

Figure-29 Device information

Hardware version: The version of the main circuit board of the instrument.
Software version: The software version number of the microcontroller on the main circuit board of the instrument.
HMI version: HMI software version number.
SN: The factory serial number of the instrument.

8.5.3 Turntable reset

If it is found that the measurement deviation is too large during the measurement, or the measured value fluctuates too much between multiple points during measurement, it may be that the reset position of the turntable is biased. At this time, the reset position of the turntable needs to be corrected by using the reset function of the turntable. The proofreading method is as follows: In the system setting interface, click "**Turntable Reset**", the measurement hole of the turntable will automatically turn to the reset position, check whether the scale line at the center position on the edge of the turntable is aligned with the reset scale line on the upper edge of the instrument, if not, you need to readjust the turntable position (as shown in **Figure 30).**

Figure-30 Scale line

Adjustment method: Pull out the plastic cover at the center of the turntable, loosen the screw to adjust the scale line of the turntable to align with the reset scale line, and tighten the screw.

8.5.4 Adjust screen brightness

The screen brightness range is between 20-100, slide the brightness adjustment bar left and right to select the appropriate brightness.

9. Troubleshooting

No.	Description	Cause of issue	Method of exclusion	Illustrate
1	No response when pressing the power switch	The fuse of the power supply is blown.	Replace the power fuse.	The power fuse socket is above the power plug.
		The transformer inside the instrument or the components on the circuit board are damaged.		
2	The power-on turntable can be rotated, but there is no display on the LCD screen	LCD display damaged	LCD monitor replacement	
3	The boot display is normal, but the turntable does not rotate	The fixing screw of the turntable is loose	Tighten the fixing screws of the turntable	
		The driving part of the turntable is damaged		
4	Cannot perform a touch operation	The touch part of the LCD monitor is damaged	Replace the LCD monitor	
5	Large single measurement fluctuation range	The reset position of the turntable is inaccurate	Adjust the reset position of the turntable	
		There are stolen goods on the measuring disc	Clean the surface of the measuring disc	
		There is a strong magnetic field around the instrument	Turn off the strong magnetic field equipment or keep the instrument away from the strong magnetic field	

10. Accessories

Standard Accessories

S. No	Accessory Name	Quantity
1	Standard oil samples	100 pcs
2	Oil box	1
3	Power adapter	1

11. Appendix

11.1 PQ index meaning

The PQ index test is not to measure the absolute content of ferromagnetic abrasive particles in the oil sample but to monitor the changing trend of the ferromagnetic abrasive particle content in the oil sample. The PQ index must change more than 10% relative to be effective. The PQ index of the empty bottle and new oil is often not zero, which is also a normal phenomenon and will not affect the trend analysis if the readings of the same empty bottle or new oil are consistent. The oil spectroscopic analysis method can measure the ppm content of iron, but the data measured by oil spectroscopic analysis is not very accurate, because the spectroscopic technique is not sensitive to large particles, and the injection is not uniform. Oil spectroscopic techniques are generally most effective on oil-like wear particles smaller than 5 μm. Depending on the shape of the associated abrasive particles, the oil spectroscopic analysis results will vary. Oil spectroscopic analysis and PQ index analysis can be used together to more effectively analyze the content and particle size of iron abrasive particles in oil samples. If the PQ index is less than the spectroscopically determined ppm iron content, almost all iron abrasive particles are smaller than 5 μm in size (this is usually the case for corrosive abrasive particles). If the PQ index is similar to or even greater than the ppm content, it is necessary to use analytical ferrography to detect the presence of large abrasive particles. PQ analysis is only effective for the wear monitoring of iron and nickel materials, but not for the wear monitoring of aluminum engines and white alloy bearings, but it can also detect relatively large non-ferromagnetic metal particles produced by diesel engine filter damage, can be used to diagnose such faults.

11.2 Data communication between the iron gauge and computer

Use the random USB to RS232 serial communication cable to connect the DB9 serial communication port of the iron gauge to the PC and use the random PC serial communication software "UartAssist.exe" to perform communication tests. The driver "CDM212364_Setup" and the communication software "UartAssist.exe" of the USB to RS232 serial communication line are placed in the random U disk. The serial communication test software "UartAssist.exe" is a free software, which is only used to test the serial communication function of the iron gauge, and customers can also use other serial communication tools for testing. Save the driver and communication software to the computer, and carry out the communication test according to the following steps:

1) Click **"CDM212364_Setup"** to start installing the driver.
2) Click **"Extract"** to enter the next step, the driver installation language will change with the system.
3) Click **"Next"** to enter the next installation interface.
4) Click "**I accept this agreement**", and then click **"Next"** to enter the next installation interface.
5) Wait for a while when the following interface appears, and it will jump to the next interface after completion.

6) When the following interface appears, it means that the driver installation has been completed. Click the **"Finish"** button to indicate that the driver installation has been completed (as shown in **Figure 31**).

Figure-31

Figure-32

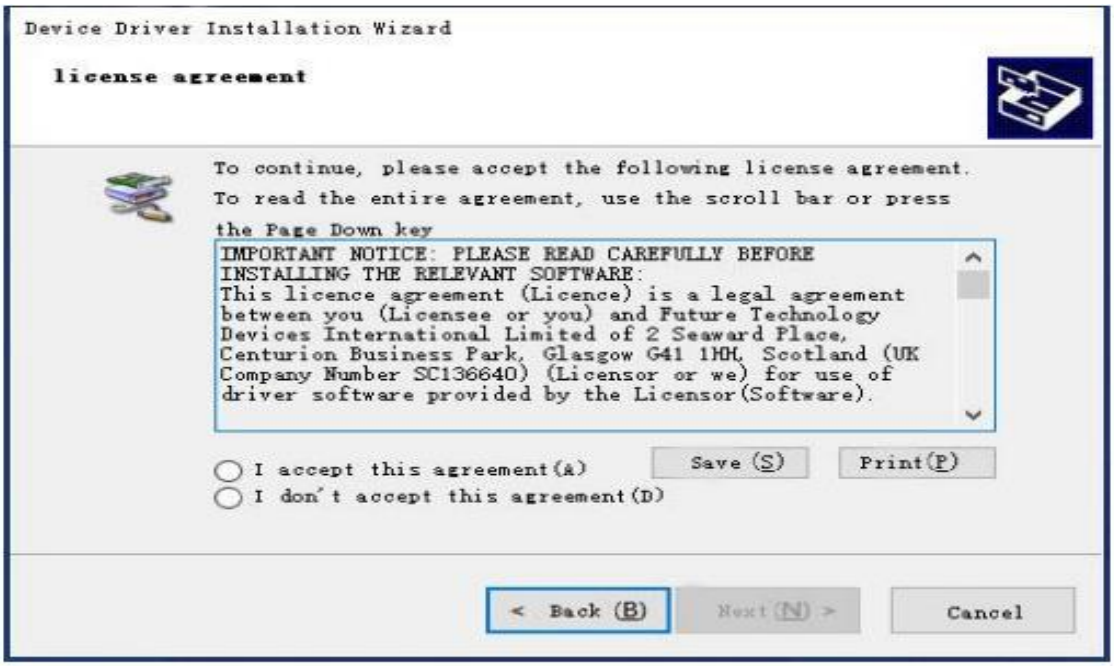

Figure-33

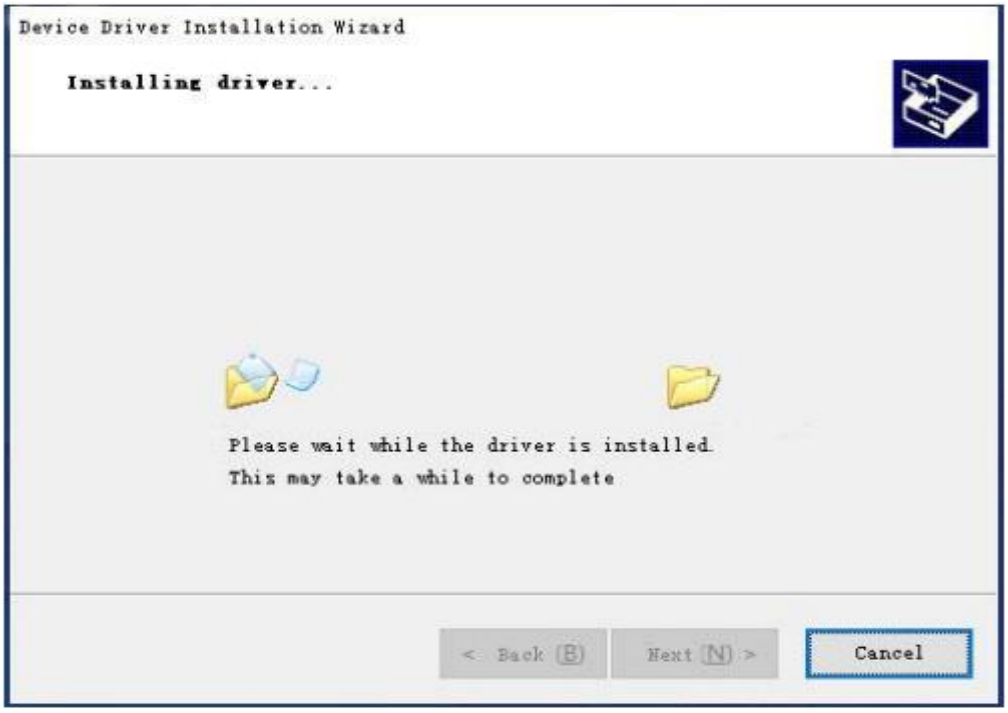

Figure-34

Figure-35

7) Insert the USB interface of the supplied USB to RS232 converter into the computer In the USB socket, the computer prompts to find new hardware and installs the driver automatically.
8) Open computer management, click "**Device Manager**", and open "Port (COM and LPT)" If you find a new " USB Serial Port " under the port, it means that the driver of the converter has been installed correctly, check the connection The corresponding COM port name in the example is COM3.
9) Open the " UartAssist.exe " serial port debugging assistant software, select the corresponding COM interface (COM3 in the example) in the "serial port number", the baud rate is 9600, the parity bit is NONE, the data bit is 8, stop Bit is 1, click the **"Open"** button to open the serial port, select "ASCII" in the "Receive Settings" to receive data in ASCII mode. When the iron gauge starts measuring, it will send Once the measurement data is sent to the serial port, the receiving window of the serial port debugging assistant software will display the received data.