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1. Summary

NHA-4/505 Automotive Emission Analyzer is for measuring CO, HC and CO_2 in automotive emissions by the principle of non-dividing infrared absorption, measuring NO(NOT FOR NHA-405) and O_2 by the principle electrochemical battery, and calculate the excessive air coefficient λ based on the composition of CO, CO_2, HC and O_2 measured. The optional inductive tachometric jaw and temperature probe are for measuring the revolving speed of the engine and the oil temperature while testing the emissions.

This instrument is assembled with foreign advanced technology and a complete set of sensors (modules), and is equipped with microprocessor and micro printer. It is a kind of portable intellectual instrument with liquid crystal display and Chinese or English interface.

Besides the real-time test function, this instrument also has the special programs for testing in idling and dual-idling operating modes (according to the national standard GB 18285-2005 "Measurement of Gasoline Automotive Emission – Dual-idling Method"), to control the testing progress automatically. Therefore, it is very convenient to make dual-idling emission measurement. This machine can be communicated with the controlling system of chassis dynamometer for ASM testing. This instrument complies with the requirements of International Measurement Rules OIML R99/1998 (E) made by the Organization of International Measurement Law (OIML) for Class-0 instruments, and is applicable for environmental departments, motor vehicle inspection stations, automotive manufacturing factories, and automobile repairing shops.

2. Specifications and Technical Parameters

2.1 Operation Environmental Condition

Temperature: 5℃～40℃

Relative humidity: ≤ 90%

Atmospheric pressure: 86.0kPa～106.0kPa

Power supply: 187V～242V, 50Hz ± 2%

2.2 Measurement Range

CO: 0～10% (10^{-2}) vol.

HC: 0～10000ppm (10^{-6}) vol., n-hexane equivalent.

CO_2: 0～20% (10^{-2}) vol.

O_2: 0～25% (10^{-2}) vol.

NO: 0～5000ppm (10^{-6}) vol. (NOT FOR NHA-405)

2.3 Measuring Methods

Exhaust Emission: Insert the sampling probe into the vehicle tailpipe for 400mm for direct sampling. The sampling probe is 900mm long, and the sampling pipe is 5m long.

Oil Temperature: Insert the temperature probe into the hole of the engine oil scale. The protection tube is 600mm long, and the lead wire is 5m long.

Revolving Speed: Clamp the measuring jaw onto the ignition lead between the distributor and spark

plugs on the 1st cylinder of the engine. The lead of the measuring jaw is 5m long.

2.4 Warm-up Time

Less than 10 min. (ambient temperature ≥20℃)

2.5 Resolution

CO: 0.01% vol.

HC: 1 ppm vol., n-hexane equivalent.

CO_2: 0.01% vol.

O_2: 0.01% vol.

NO: 1ppm vol. (NOT FOR NHA-405)

2.6 Allowed Indication Error

CO: ± 0.03% vol. (absolute error) or ± 5% (relative error);

HC: ± 10ppm vol. (absolute error) or ± 5% (relative error), n-hexane equivalent;

CO_2: ± 0.5% vol. (absolute error) or ± 5% (relative error);

O_2: ± 0.1% vol. (absolute error) or ± 5% (relative error);

NO: ± 25ppm vol. (absolute error) or ± 4% (relative error). (NOT FOR NHA-405)

2.7 Time Stability

After warm up, the zero drift and span drift shall not go beyond its allowed indication error.

2.8 Repeatability

The indicated repeatability shall not go beyond 1/2 of its absolute allowed indication error.

2.9 Output Interface

RS232 serial communication port.

2.10. Outer Dimension

450mm×260mm×180mm (L×W×H)

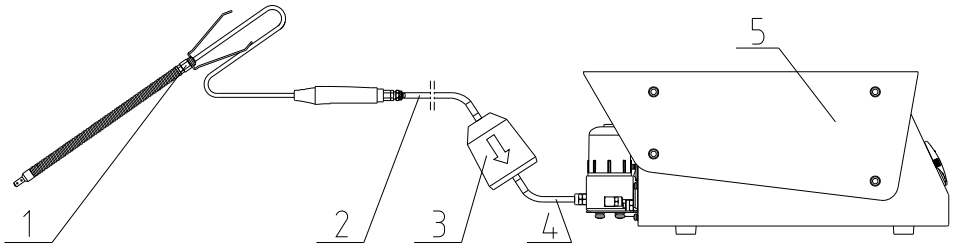
2.11. Net Weight

7kg

3. Composition and Functions of the Keys, Switches and Components

3.1 Composition

As shown on Fig. 1, the instrument is composed of the instrument body, short tube, pre-filter, sampling pipe, sampling probe, and built-in micro printer.



1. Sampling Probe; 2. Sampling Pipe; 3. Pre-filter; 4. Short Tube; 5. Instrument Body;

Figure 1 Composition of the Instrument

3.2 Front Panel

The front panel of the instrument and all parts on it are shown in Figure 2.

Functions of all parts on front panel:

1. "S" key: Horizontally move the cursor (triangular arrowhead) on the liquid crystal display to select the item required.

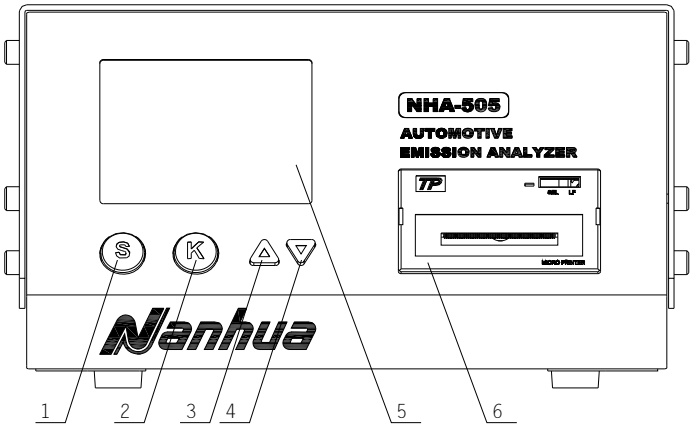
2. "K" key: Enter the item selected.

3. "▲" key: Move the cursor on the liquid crystal display upward to select the item required, adjust the contrast of characters and pictures on the display, and modify the setting values of the calibration gas before calibration.

4. "▼" key: Move the cursor on the liquid crystal display downward to select the item required. The other functions are same as "▲" key.

5. Liquid crystal display: Display the menu and the measured data.

Note: During warm up or under the main menu, it is able to adjust the contrast of characters and pictures on the display by pressing "▲" or "▼". User may make necessary adjustments for the clearest display.



1. "S" key 2. "K" key 3. "▲" key 4. "▼" key 5. Liquid Crystal Display 6. Printer

Figure 2. Front Panel

3.3 Rear Panel

The layout of the rear panel and all parts on it are shown in Figure 3.

Functions of the parts on rear panel,

1--Cooling Fan: Exhaust the air inside the instrument to prevent it from internally overheated.

2--Zero Gas Filter: Filter dust from the air.

3--Gas Outlet of O_2 Sensor: Outlet for sampling gas after O_2 measurement.

4--Gas Outlet of NO_x Sensor: Outlet for sampling gas after NO_x measurement.

5--Revolving Speed Signal Socket: Signal input from tachometric measuring jaw.

6--Oil Temperature Signal Socket: Input signal from oil temperature probe.

7--Power Socket and Switch: Socket for 220V AC power supply, switch for power on and off, with built-in 1A fuse and mains noise filter.

8--RS232 Output Signal Socket: RS232 port for communication with external computer.

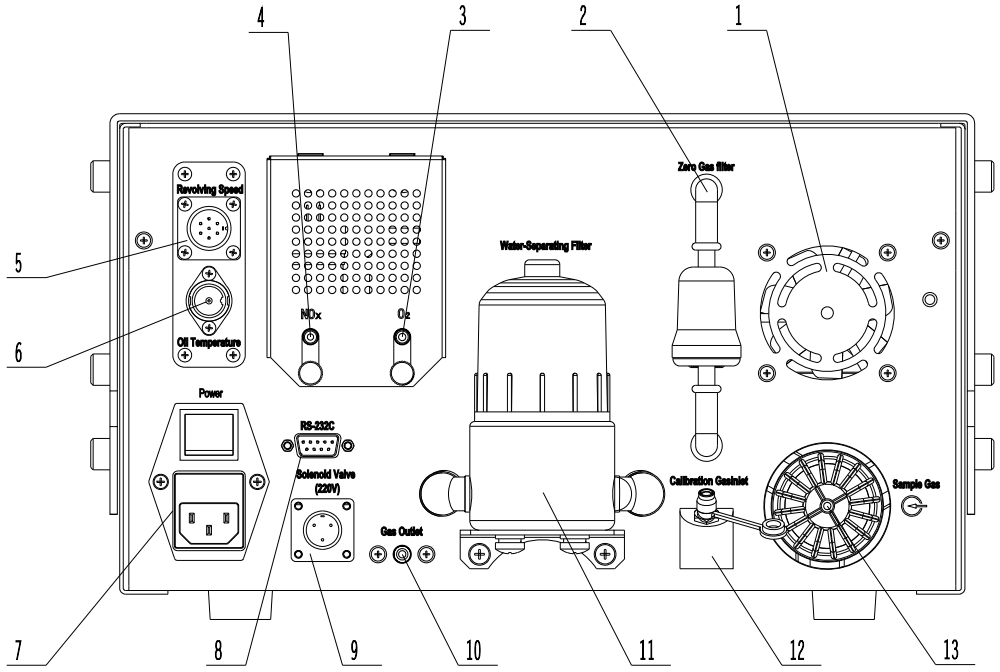
9--Solenoid Valve Socket: Connect with drain solenoid valve;

10--Main Gas Outlet: Outlet for sampling gas after measurement.

11--Water-Separating Filter: Filter oil, water and dust from the exhaust gas, replace the big / small filter element as per requirement.

12--Standard Gas Inlet: Inlet for standard gas during calibration.

13--Condenser and Sampling Gas Inlet: Connect the sample gas inlet via sampling pipe and pre-filter outlet, the condenser can lower the temperature of sample gas, prevent the gas entering the bench from producing condense water.



1-Cooling Fan 2-Zero Gas Filter 3-Gas Outlet of O_2 Sensor 4-Gas Outlet of NO_x Sensor 5-Revolving Speed Signal Socket 6-Oil Temperature Signal Socket 7- Power Socket and Switch Figure 8-RS232 Output Signal Socket 9-Solenoid Valve 10-Main Gas Outlet 11-Water-Separating Filter 12-Standard Gas Inlet 13-Condenser and Sampling Gas Inlet.

Figure 3. Rear Panel of the Instrument

4. Operation

4.1 Preparation

4.1.1 Installation

a) As shown in Fig. 1, connect one end of the sampling pipe with the end of the sampling probe first, the other end with the inlet of pre-filter. Then, connect one end of the short tube with the outlet of pre-filter, the other end with the sampling gas inlet of the instrument. Check all the connections and make sure that they are firmly connected without any leakage.

b) Make sure that clean filter elements and filter paper have been installed in pre-filter, water filter, dust filter and secondary filter respectively.

c) Connect the power cable, oil temperature probe and tachometric measuring jaw to the power socket, oil temperature signal socket and revolving speed signal socket of the instrument respectively.

4.1.2 Warm-up

Plug the power cable into the 220 VAC power socket, turn on the power switch to warm up the instrument. " Warming up, please wait…. XXX sec" will appear on the lower part of the display. "XXX" means the countdown warm-up time. The total warm up time is 600 seconds (10 minutes).

Note: The 600 seconds warm-up time is only for operation under ambient temperature at about 20℃ for reaching accuracy. If ambient temperature is higher than 20℃, the warm-up will be shorter. If it is lower than 20℃, the warm-up will be longer.

After power-on for 1 minute, press ENTER to exit, but the accuracy can not be guaranteed.

4.1.3 Leak check

After warm up, the instrument automatically enters the sub-menu of "Leak Check" to check leakage of the gas path system. A prompt will appear on the lower part of the display as "Cover the probe with sheath, return by K key". User shall operate accordingly and press K key. Then, another prompt will appear as "Leak checking…XX sec". "XX sec. means the leak check time left by count down (totally 10 seconds).

After leak check, if leakage is found, a prompt will appear as "Leakage, please check... Press K key to check again". User shall check the whole gas path carefully, and eliminate any leakage found. If no leakage, a prompt "OK, return by K key" will appear. Press K key to enter Auto Zeroing.

4.1.4 Automatic Zeroing

After entering Auto Zeroing, a prompt appears on the lower part of the display as "Zeroing. Please wait……". Once the zeroing is completed, "OK" appears on the right lower corner of the display. Several seconds later, the prompt on the lower part disappears, the display switches to Main Menu. If zeroing is not normal, "Zeroing error" appears on the lower part of the display, and the display switches to Main Menu in several seconds.

4.2 Main Menu

The main menu of the instrument is shown as Fig. 4. The upper part is for prompt, the middle part is for display of real-time values of HC, CO, CO_2, O_2, NO, n (revolving speed), λ (excessive air coefficient) and T (oil temperature), and there are five sub-menus on the lower part which includes "MEAS", "ZERO", "CAL.", "LEAK", "SET".

Press S key to move the cursor to the item to be selected, press K key to enter such sub-menu. Conversely, every return from the sub-menu will return to the main menu.

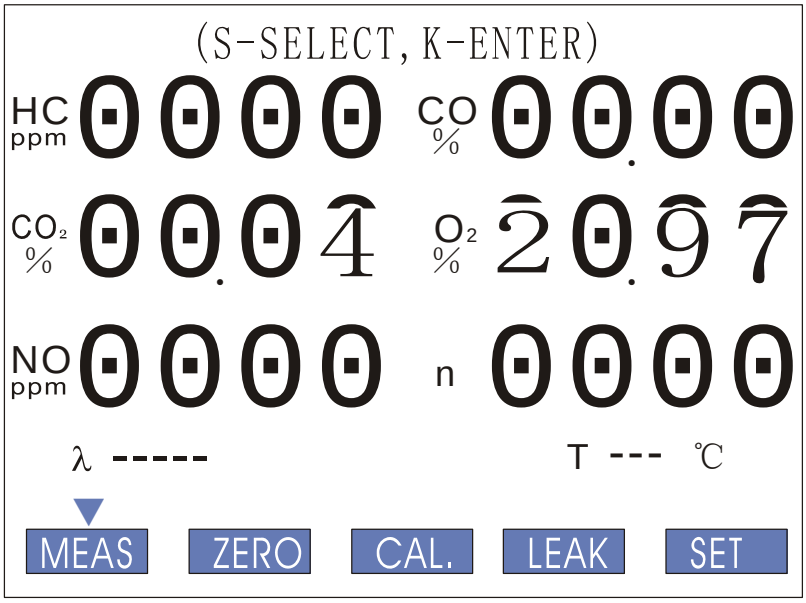


Fig. 4 Main Menu on display

4.3 Zeroing

Automatic zeroing is provided and it works periodically (once half an hour), usually zeroing is not necessary. However, if it is necessary for zeroing at the decision of user, return to the main menu from the current sub-menu, press S key to move the cursor to "Zero", and press K key to enable zeroing. The sub-menu items on the lower part of the display will change to be a prompt as "Zeroing. Please wait……". After zeroing, "OK" appears on the right lower corner of the display. After several seconds, the five sub-menu items re-appear to replace the prompt on the lower part of the display.

4.4 Calibration

The instrument may drift and the sensors may be aging during the service. Therefore, it is necessary to make span calibration after a period of operation (generally 3-6 months). The O_2 sensor and NO sensor shall be replaced after about 1-year operation. After NO sensor is replaced, clear NO aging signal and re-calibrate this channel before new operation.

4.4.1 Calibration Gas Selection

Span calibration requires two types of calibration gases, 3-component and 1-component standard gases, the composition is as follows,

a) 3-component calibration gas

CO: about 3.5% vol.

C_3H_8 (propane): about 2000ppm (0.2%) vol.

CO_2: about 14% vol.

N_2 (nitrogen): residue

b) 1-component calibration gas (NOT FOR NHA-405)

NO: about 1000ppm (0.1%) vol.

N_2 (nitrogen): residue

The actual calibration values shall be subject to the nominal values on the tag of the standard gas cylinder, without exceeding 15% of the tag values. NO calibration gas is excluded in the accessories of the instrument because of the cylinder and the lifetime. Please contact us for purchasing NO calibration gas.

4.4.2 Calibration of spans of HC, CO and CO_2 channel

Follow the calibration steps below:

a) Zeroing: Before calibration, calibrate zero as per the description in 4.3.

b) Press S key in Main Menu, move the cursor to "Cal." option. Press K key to enter the sub-menu of "Cal." ("2. NO Calibration and 3 NEW NO Sensor" NOT FOR NHA-405)

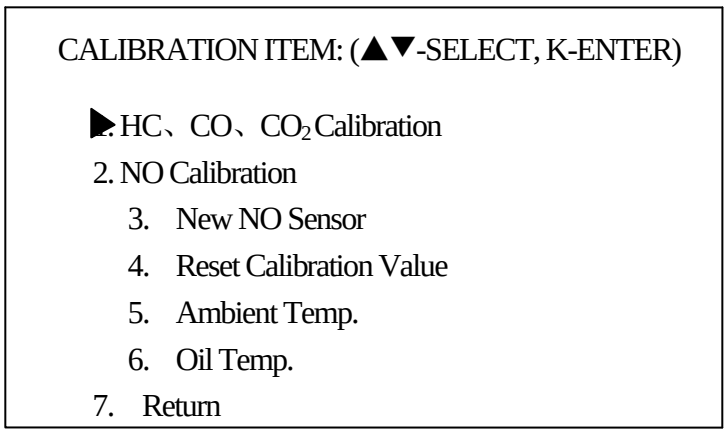


Figure 5. Sub-menu of "Calibration"

c) Press "▲" or "▼" to move the cursor to item "1. HC, CO, CO_2 Calibration", press K key to enter the setting interface of "Standard Gas Concentration" (Fig. 6).

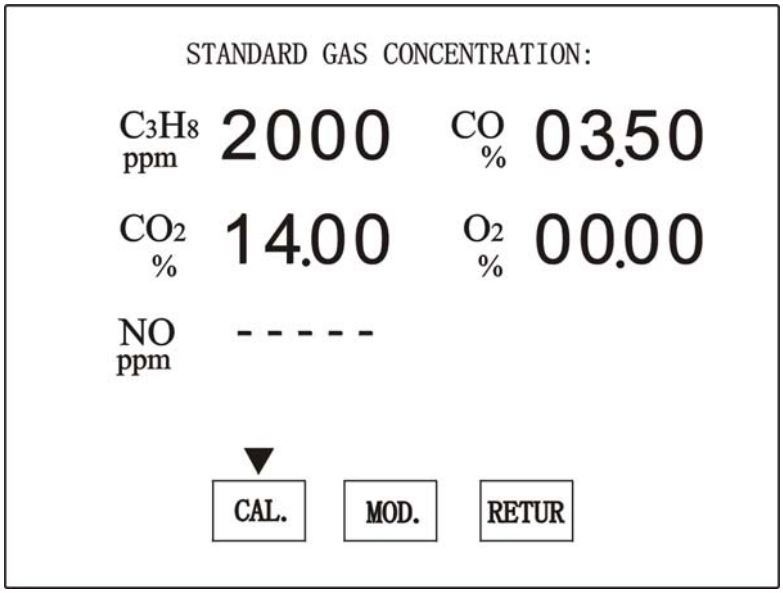


Figure 6. Setting interface of "Standard Gas Concentration"

d) The setting calibration gas values displayed are the standard gas values used for the previous calibration. If they are different from the 3-component standard gas values for this calibration, press S key to move the cursor to "Mod" item, press K key to move the cursor "▲" to C_3H_8. According to the prompts on the upper part of the display, modify the C_3H_8 setting value as the nominal value on the cylinder. After such modification, press S key to move the cursor rightward to CO, and modify the setting of CO. Then press S key again to move the cursor downward to CO_2 for further modification. After all the three channels are modified, press S key to move the cursor "▲" back to "Cal." and it will become "▼"。

e) If the setting values of the standard gases in HC, CO and CO_2 channels comply with the nominal values of the 3-component gas cylinder being used, or if all the setting values are modified, press K key when the cursor is at "Cal.". At this time, a prompt appears on the upper part of the display as "Flow standard gas, press K key when the data is stable". Two items for selection, "Cal." and "Retur." appear on the lower part of the display, and the cursor automatically moves to "Cal.".

f) Follow the prompts, introduce the 3-component standard gas through the gas inlet, press K key when the readings are stable. Then, a prompt appears on the lower part of the display as "Calibrating……", which will change to "OK" several seconds later, meaning that the span of HC, CO and CO_2 channels have been calibrated. Press any key to return to Main Menu.

Once K key is pressed without flowing standard gas to the instrument, a prompt appears on the upper part of the display as "No standard gas. Calibration fails". Press any key to return to Main Menu.

g) If no calibration is required any more under the sub-menu of "Cal.", press "▼" to move the cursor downward to "7. Return", press K key to return to Main Menu.

h) After calibration, take off the calibration gas cylinder before any other operation.

Note: Check valve is assembled at the inlet of calibration gas on the instrument. When flowing calibration gas into the instrument, aim the nozzle of the calibration gas cylinder at the inlet of calibration gas, slightly force it downward to open the valve, the calibration gas will enter the instrument.

When using any calibration gas cylinder other than the one supplied by us, if the nozzle of the gas cylinder is inapplicable for the instrument and unable to open the check valve, use the "adapter" in the instrument accessories. To use it, fasten it on the inlet of calibration gas, the check valve will be opened.

4.4.3 Calibration of NO Channel(NOT FOR NHA-405)

a) Zeroing: Follow the description in 4.3 for zeroing before span calibration.

b) Press S key on the main menu to move the cursor to "Cal.". Press K key to enter the sub-menu of "Cal.".

c) Press "▲" or "▼" to move the cursor to "NO Calibration". Press K to enter the setting interface of "Standard Gas Concentration" as shown in Fig. 6.

d) If the setting calibration gas values are different from the 1-component standard gas for this calibration, press S key to move the cursor to "Mod.", and press K key to move the cursor "▲" to NO. Then, operate as per the prompts on the upper part of the display to modify the setting value of NO to comply with the nominal value on the cylinder. After modification, press S key to move the cursor "▲"

to "Cal." and it will change to "▼".

e) If the setting standard gas values comply with the nominal values on the cylinder being used, or if all the settings have been modified, press K key when the cursor is at "Cal.". A prompt appears on the upper part of the display as "Flow standard gas, press K key when the data is stable". Two items for selection, "Cal." and "Return" appear on the lower part of the display, the cursor automatically moves to "Cal.".

If the 1-component standard gas is flowed through the standard gas inlet as indicated in the prompt, press K key when the reading is stable. Then, a prompt appears on the lower part of the display as "Calibrating……", which will change to "OK" several seconds late. Press any key to return to Main Menu.

Once K key is pressed without flowing standard gas to the instrument, a prompt appears on the upper part of the display as "Calibration error", the cursor moves to "Return" automatically. Press any key to return to the main menu.

Note: Introduce NO standard gas through the sampling gas inlet with a flow rate within 5～6L/min.

Before introducing NO standard gas, do not calibrate it.

4.4.4 Reset Original Calibration Value

Press key ▲or ▼, move the cursor to item 4 "Reset Calibration Value", press K key, the original values for HC, CO, CO2 channel will be reset. A prompt "Reset OK" will be showed at the lower part of the display.

Note: Only HC, CO and CO2 channel can be reset; O2 and NO channel can not be reset.

4.4.5 Calibration of Ambient Temperature

If it is necessary, ambient temperature can be calibrated.

Calibration steps:

a) Insert oil temperature probe, wait for 5 seconds.
b) Press S key on the main menu, move the cursor to "Calibration", press K key, enter the sub-menu 'Calibration". (see Fig. 5)
c) Press ▲ or ▼ key, move the cursor to item "5. Ambient Temperature Calibration", press K key, enter this sub-menu, a prompt appears as "Please insert temperature sensor into normal temperature, modify the normal temperature by ▲▼, press K key to calibrate when the temperature becomes stable, or press S key to return." Operate as per the prompts displayed.

4.4.6 Calibration of Oil Temperature

After the instrument is used for some time or if it is necessary, the oil temperature can be calibrated.

Calibration steps:

a) Press S key on the main menu, move the cursor to the item "Calibration", press K key, enter the sub-menu 'Calibration". (see Fig. 5)
b) Press ▼ key, select item "6. Temperature Calibration", press K key, enter the interface as showed below,

Temperature Calibration

1. Room Temperature Calibration

Put the temperature probe indoors, after the temperature is stable, press K key to calibrate and press S key to exit.

Standard temperature: 028 ℃

Measured temperature probe: 025 ℃

Figure 7. Interface 1 of "Temperature Calibration"

c) Press K key, a prompt shows on the lower part of the display "Calibration OK."

d) If the temperature probe is not inserted, the measured temperature probe will be displayed "-------". If K key is pressed, a prompt as "Temperature probe is not inserted, calibration fails." appears at the lower part of the display.

e) After calibrating the indoor temperature, enter the following interface 2 of "Temperature Calibration" (Fig. 8),

Temperature Calibration

2. Oil Temperature Calibration

Insert temperature probe into standard temperature, use ▲▼key to modify the temperature setting. After the temperature is stable, press K key to calibrate and press S key to exit.

Standard temperature: 099℃

Measured temperature probe: 096℃

Figure 8. Interface 2 of "Temperature Calibration"

f) According to the prompts on "Temperature Calibration" interface, put the temperature probe into 85 ℃ hot water (100℃ boiled water is recommend).

g) Press ▲▼key, the "Standard Temperature" displayed is same as the one measured by temperature meter. Press K key, complete the calibration for high-temperature point. Then press K key, return to Main Menu.

h) If K key is pressed when the water temperature is less than 80℃ or the oil temperature probe is not inserted into hot water, a prompt will be displayed as "Calibration value is out of range, calibration fails, press K key to exit.". Under this circumstance, hot water more than 85℃ should be used or insert the temperature probe, then repeat the above steps.

4.5 Leak Check

Automatic leak check will be done after warm-up. User may take leak check any time as required.

Steps for leak check:

a) Press S key in Main Menu to move the cursor to "Leak". Press K key to enter the sub-menu of "Leak".

b) Follow the prompts on the lower part of the display, and clog the sampling probe tip by sheath, press K key, the leak check will be completed in 18 seconds. If leakage is found, a prompt appears as "Leakage. Please check. Press K to re-check……". If no leakage is found, "OK, press K key to return" appears.

c) In case of any leakage, check the gas path carefully and eliminate it. Otherwise, "Leakage. Please check. Press K key to re-check……" will be always displayed. If there is no leakage, press K key to return to Main Menu.

4.6 Setting

If user needs to set measuring method, engine stroke or fuel type, use the sub-menu "Setting" (Fig. 9). Press S key in Main Menu to move the cursor to "Setting", press K key to enter this sub-menu.

4.6.1 Setting Measuring Method

There are 3 measuring methods: General measurement, Idling measurement and Dual-idling measurement.

General measurement is for continuously displaying the instant measured data, which is applicable for observing or monitoring real-time values of emissions and for ASM testing.

Idling measurement is designed according to the provisions for idling measurement program under China GB/T 3845/93 "Measurement of Gasoline Automobile Emission – Idling Method".

Dual-idling measurement is designed according to the provisions for dual-idling measurement program under China GB18285-2005 "Limits and measuring methods for exhaust pollutants from vehicles equipped with ignition engine under dual-idling speed conditions and simple driving mode condition".

The default setting is "General".

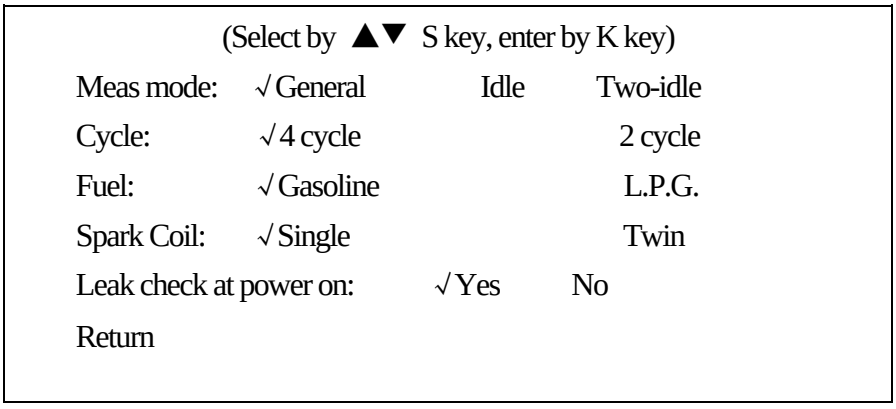


Figure 9. Sub-menu of "Setting"

The measurement method is set as per the following steps:

According to the prompt on the upper part of the display in the sub-menu of "Setting", press "▲" or "▼" to move the cursor to "Mase Mode", press S key, " √" alternatively appears at "General", "Idle" and "Two-Idle".

4.6.2 Setting Engine Stroke

Select the engine stroke (cycle) required in the way described in 4.6.1 according to the prompt on the upper part of the display under the sub-menu of "Setting".

The default engine stroke is "4 cycle".

4.6.3 Setting Spark Coil

Spark Coil represents the ignition times for each stroke, there are 2 types, single and twin. Select the spark coil required in the way described in 4.6.1 according to the prompt on the upper part of the display in the sub-menu of "Setting".

The default ignition is "Single".

Note: Usually, "Single" is for engine with "distributor", and "twin" for engine without "distributor". Incorrect ignition setting may result in inaccurate or unstable measurement of revolving speed.

4.6.4 Setting Fuel Type

Select the fuel type required in the way described in 4.6.1 according to the prompt on the upper part of the display in the sub-menu of "Setting".

The default fuel type is "Gasoline".

Note: The HC indication means n-hexane equivalent if fuel type is set "gasoline", and the HC indication means propane equivalent if fuel type is set "L.P.G.".

4.6.5 Setting Leak Check at Power-on

Set leak check required in the way described in 4.6.1 according to the prompt on the upper part of the display in the sub-menu of "Setting". "Yes" means automatic leak check at each power-on, "No" means no automatic leak check at power-on.

The default leak check at power-on is "Yes".

4.6.6 Exit "Setting" Menu

Refer to 4.6.1 to terminate setting and exit this submenu, move the cursor to "Return", press K key and return to the main menu. Before the exit, all the setting values will be saved.

4.7 Measurement

Press S key in Min Mnu to move the cursor to "Meas", and press K key. According to the previous set measurement method, enter the sub-menu – "General Measurement", "Idling Measurement" or "Dual-idling Measurement", and enable the relevant measurement (refer to 4.7.1, 4.7.2 or 4.7.3).

4.7.1 General Measurement

The sub-menu "General Meas" (as shown in Fig. 10) is composed of three parts. The upper part shows the name of the sub-menu and the prompts for operation, the middle part shows the real-time values

measured for HC, CO, CO_2, O_2, NO, n (revolving speed), λ (excessive air coefficient) and T (oil temperature), and the lower part is for prompts and three options. There is a measuring scale indicating the current flow on the right lower corner. There are 5 grids, 3-5 grids means normal flow, 1 or no grid means insufficient flow and the sampling system is clogged. In case of 1 or no grid, the symbol of "Flow" on the lower part of the flow measuring scale will flash (Under such circumstance, user shall remove the clogging immediately in the way described in 6.1 below).

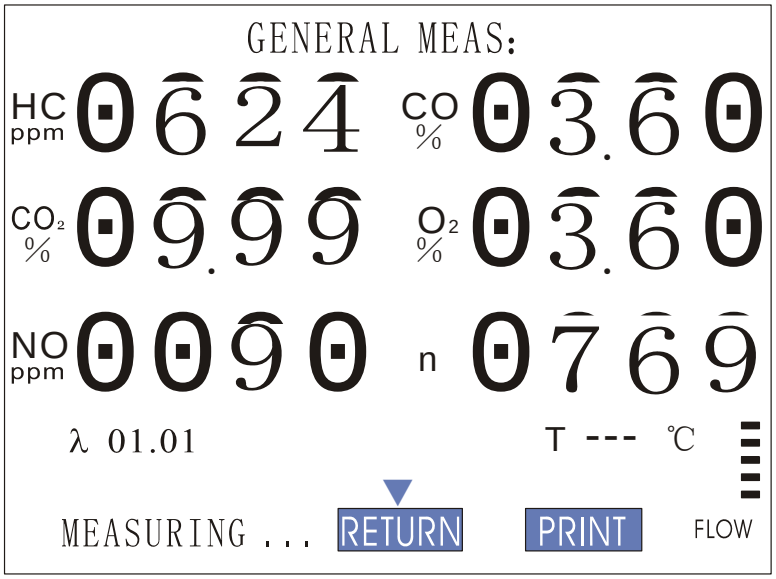


Figure 10. Sub-menu of "General measurement"

The gas pump starts after "General Meas" is selected and ran. Insert the sampling probe into the vehicle tailpipe in the depth of 400mm, and the real-time values of HC, CO, CO_2, O_2 and NO in the emission and λ will be displayed on LCD. If the tachometric jaw and oil temperature probe are installed as per the steps described in 4.7.2.1, the real-time values of engine revolving speed (n) and oil temperature (T) will also be displayed.

4.7.1.1 Stop

Press S key to stop General Measurement and exit, move the cursor to "STOP", press K key and return to Main Menu.

4.7.1.1 Print

To print the measurement result, press S key to move the cursor to "Print", press K key and return to Main Menu.

4.7.2 Idling Speed Measurement

The sub-menu of "Idling Speed Measurement" is composed of three parts. The upper part shows the name of the sub-menu, the middle part shows real-time values measured for HC, CO, CO_2, O_2, NO, n, λ and T, and the lower part is for prompts. There is a measuring scale for flow with a symbol of "Flow" on the right lower corner.

4.7.2.1 Preparation

Clamp the tachometric measuring jaw onto the ignition lead between the distributor and spark plug of 1st cylinder of the engine. Be careful that the arrowhead on the back of the jaw shall aim at the spark plug, otherwise, wrong connection may cause incorrect signal of revolving speed. Then, insert the oil temperature probe into the oil scale hole on the engine until the sampling probe contacts with the oil.

4.7.2.2 HC Residue and Engine Warm-up

a) In the sub-menu of "Idling Measurement", the instrument starts to check the HC residue. A prompt "Checking HC Residue…XX seconds" appears on the lower part of the display, "XX seconds" means the remaining checking time (by counting down, Max. 30 seconds). After checking, a prompt as "Checking HC residue OK" appears for a successful check, or a prompt as "HC residue is too high, clear the piping…" will appear for a failure. In case of the latter, user may eliminate the trouble immediately in the way described in 6.2.

b) After checking HC residue, the name of the sub-menu on the upper part of the display will change to a prompt as "Rated R.P.M.: 5000 ▲▼ for modify, K key for enter". Press ▲ or ▼ to set the prompted rated revolving speed as the nominal rated revolving speed of the engine (accuracy: 100r/min), then press K key for confirmation.

c) Press K key to warm up the engine. If the oil temperature is lower than 80℃,a prompt on the upper part of the display will change to "Accelerate to 3500r/min". The driver shall accelerate the engine, and watch the changing revolving speed on the display until it reaches about 3500r/min.

Note: Only when the rated revolving speed is 5000r/min, the prompt on the display will be "Accelerate to 3500r/min". If the rated revolving speed is any other value, the prompt will be "Please accelerate to XXXX r/min", XXXX equals to 0.7 times of the setting of rated revolving speed. The 2500 r/min described in 4.9.3 below is of the same condition.

d) When the revolving speed reaches 3500 r/min, a prompt as "Keep 3500 r/min" appear on the display, and "XX seconds" by counting down will be displayed on the lower part (totally 30 seconds). After that, the instrument is ready for measurement.

4.7.2.3 Idling Speed Measurement

a) After warm-up, a prompt as "Decelerate to idling speed…" appears on the upper part of the display. The driver shall release the accelerator pedal to decelerate the vehicle. When the revolving speed falls to 1100 r/min or below, the prompt on the upper part of the display will change to "Keep idling speed…" and the prompt on the lower part will be "Insert sampling probe……".

b) When the prompt as "Insert sampling probe……" appears, insert the sampling probe into the vehicle tailpipe for a depth of 400mm, and keep the idling speed.

c) The instrument begins to sample the emissions when the sampling probe is inserted well, a prompt as "Sampling……XX seconds" appears on the prompt area. "XX seconds" means the remaining sampling time (by count down. Totally 45 seconds, the first 15s is for preparation, and the final 30s is for actual sampling). The idling measurement is completed at the end of sampling by counting down.

4.7.2.4 Read Measurement Data and Terminate Measurement

a) At the end of idling speed measurement, the display will change to the interface of "Measurement Finish", with the max. value, min. value and average value of HC, CO, CO_2 , O_2 , NO and n, as well as λ

and oil temperature displayed on the upper part, and "Retur" and "Print" on the lower part.

b) To print the measurement result, press S key to move the cursor to "Print", press K key to print the data. Later, the cursor returns to "Retur" automatically.

c) To save the test result, press K key to move the cursor to "Save", press K key. The operation is same as 4.7.1.2.

d) After one measurement, take off the sampling probe from the tailpipe, remove the tachometric measuring jaw from the engine, and take out the oil temperature probe.

e) When the cursor is at "Retur", press K key to return to Main Menu, and the cursor goes back to "Measurement" automatically. To continue idling speed measurement, press K key and repeat the operations from 4.7.2.2 to 4.7.2.4.

Note: If the measuring scale for flow at the lower right corner of the display is less than 2 measures, the symbol of "Flow" will flash, which prompts clogged gas path. The measuring functions of the instrument will be locked. Press S key and K key to return to exit. Under such circumstance, user shall remove the clogging immediately in the way described in 6.2 below.

4.7.3 Dual-Idling Measurement

The sub-menu of "Dual-idling Measurement" is composed of three parts. The upper part shows the name of the sub-menu, the middle part shows real-time values measured for HC, CO, CO_2 , O_2 , NO, n , λ and T, and the lower part is for prompts. There is a measuring scale for flow and a symbol of "Flow" on the right lower corner.

4.7.3.1 Preparation

Follow the steps described in 4.7.2.1.

4.7.3.2 Checking HC residue and Engine warm-up

In the sub-menu of "Dual Idling Measurement", the instrument starts to check HC residue and warm up the engine in the same way described in 4.7.2.2.

4.7.3.3 High Idling-Speed Measurement

a) At the end of engine warm-up, the instrument starts the measurement at high idling speed, and a prompt as "Decelerate to 2500 r/min" appears on the upper part of the display. The driver shall decelerate the engine, and watch the changing revolving speed on the middle part of the display until it falls to about 2500 r/min. At this time, the prompt on the upper part of the display will change to "Keep 2500 r/min", and the prompt on the lower part will be "Insert sampling probe……". When the prompt as "Insert sampling probe……" appears, the driver shall keep the revolving speed at 2500 r/min ± 50 r/min, and the operator shall insert the sampling probe into the tailpipe for a the depth of 400mm.

b) Once the sampling probe is inserted, the prompt on the upper part of the display will be "Please keep 2500 r/min", and the prompt on the lower part will be "Sampling……XX seconds" (by counting down. Totally 45 seconds, the first 15s is for preparation, and the final 30s is for actual sampling).

If the revolving speed in the final 30 seconds exceeds 2500 r/min ± 250 r/min, a prompt "R.P.M. is out of range. Keep 2500 r/min" appears on the upper part of the display. The sampling will be stopped until the

revolving speed returns to 2500 r/min ± 250 r/min.

c) The measurement at high idling speed is completed at the end of sampling by count down, the measurement at idling speed will be started. At this time, the prompt on the lower part of the display disappears, and the prompt on the upper part will be "Decelerate to idling speed …".

4.7.3.4 Idling-Speed Measurement

a) When the prompt "Decelerate to idling speed…" appears on the upper part of the display, the driver shall decelerate the vehicle. When the revolving speed falls to 1100 r/min or below, the prompt on the upper part of the display will change to "Keep idling speed……", and the prompt on the lower part will be "Sampling……XX seconds" (by count down. Totally 45 seconds, same as 4.7.2.3).

b) The idling speed measurement is completed at the end of sampling by count down. The measurement results will be displayed as the follows,

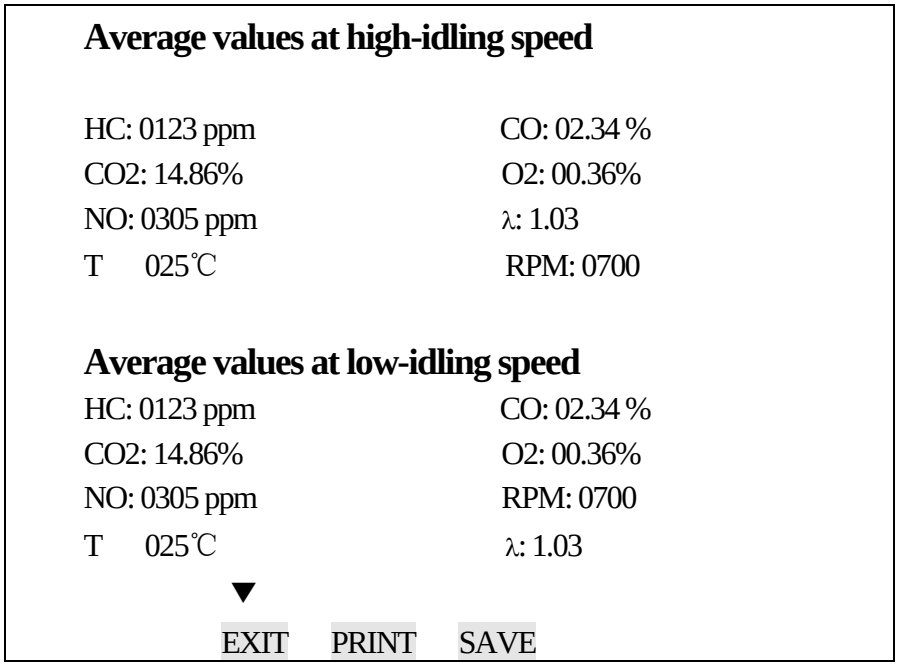


Fig. 11 Test Results of Dual-Idling Speed Measurement

4.7.3.5 Print and Save Measurement Data

Press S key to move the cursor to "PRINT", press K key to enter the interface of "Vehicle License Entry", the operation is same as 4.7.1.1. The test results for measurements at high idling speed and at low idling speed will be printed. Move the cursor to "SAVE", press K key to save the test results.

4.7.3.6 Terminate measurement

a) After one measurement, take off the sampling probe from the tailpipe, remove the tachometric measuring jaw from the engine, and take out the oil temperature probe.

b) Press K key when the cursor is at "Retur", return to Main Menu, the cursor goes back to "Measurement" automatically. To continue dual-idling measurement, press K key and repeat the operations from 4.7.3.1 to 4.7.3.5.

Note: After the measurement process and before switching off the power, instrument should be at the measurement status

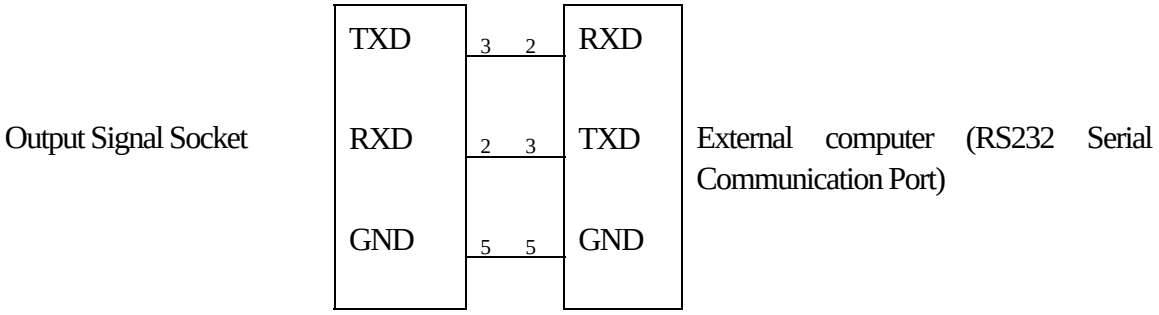
(the pump is working) for about 10 minutes. Place the sampling probe into clean air, bring clean air in the instrument to blow off the residual emissions.

5. Output Signals

The output signal socket (fast-connection socket of 9 pins) on the rear panel of the instrument is RS232 serial communication interface connected with the external computer for transmitting measurement data.

5.1 Connection and Serial Communication Parameters

5.1.1. Connection



5.1.2 RS232 Serial Communication Parameters

a) Baud rate: 9600 Baud

b) Character Length: 1 Start bits: 1; 8 Data bits; 1 Stop bits.

c) Parity: None

5.2 Data Format and Command

5.2.1 Pump On

Sent by external computer: 01H

Instrument response: ACK (06H)

5.2.2 Pump Off

Sent by external computer: 02H

Instrument response: ACK (06H)

5.2.3 Access Real-Time Data

Sent by external computer: 03H

Instrument response: ACK (06H), HC, CO, CO_2, O_2, NO(NOT FOR NHA-405), n, T, λ and check sum.

5.2.4 Setting Engine as Four Strokes

Sent by external computer: 04H

Instrument response: ACK (06H)

5.2.5 Setting Engine as Two Strokes

Sent by external computer: 05H

Instrument response: ACK (06H)

5.2.6 Setting Fuel Type as Gasoline

Sent by external computer: 06H

Instrument response: ACK (06H)

5.2.7 Setting Fuel Type as LPG

Sent by external computer: 07H

Instrument response: ACK (06H)

5.2.8 Setting Ignition as "Single"

Sent by external computer: 0AH

Instrument response: ACK (06H)

5.2.9 Setting Ignition as "Twin"

Sent by external computer: 0BH

Instrument response: ACK (06H)

5.2.10 Read Stored Data

Sent by external computer: 0BH

Instrument response: ACK (06H), data group, [vehicle license number, measurement time, high-idling HC, high-idling CO, high-idling Co2, high-idling O2, high-idling NO, low-idling CO, low-idling CO2, low-idling O2, low-idling NO] [……]……check sum.

Data group is the total quantity for the vehicle data saved; [……] is a group of data (33 bytes); vehicle license number is 8 byte ASCII code, measurement time is 5 binary digit, arranged by date/month/year (one byte for each); check sum is the sum for all the data (2 bytes).

5.2.11 Communication for Idling Measurement and Dual-Idling Measurement

The flow chart for idling Measurement is showed as Fig. 16, Fig. 17 is for dual-idling measurement.

5.2.12 Others

If any command is sent to the instrument during zeroing, calibration, warm up and leak check, the instrument responds BUSY (05H). If the instrument receives the non-effective command, it responds with NACK (15H).

5.2.13 Data Format

a) ACK: 06H, single byte.

b) HC: HC data, integer with symbol (two bytes), high order first, unit as ppm. For example, the measurement result of HC is 1234 ppm, the HC data will be 04D2H. (If gasoline is set as the fuel type, expressed by n-hexane equivalent; if liquefied petroleum gas is set as the fuel type, expressed by propane equivalent).

c) CO: CO data, integer with symbol (two bytes), high order first, unit as 100 times of percent. For example, the measurement result of CO is 1.23%, the CO data will be 007BH.

d) CO_2: CO_2 data, integer with symbol (two bytes), high order first, unit as 100 times of percent. For example, the measurement result of CO_2 is -0.25%, the CO_2 data will be 0FFE7H.

e) O_2: O_2 data, integer with symbol (two bytes), high order first, unit as 100 times of percent. For example, the measurement result of O_2 is 0.25%, the O_2 data will be 0019H.

f) NO: NO data, integer with symbol (two bytes), high order first, unit as ppm. For example, the measurement result of NO is 15ppm, the NO data will be 000FH. (NOT FOR NHA-405)

g) n: data of revolving speed, integer with symbol (two bytes), high order first, unit as r/min (Note: revolving speed is related to engine stroke).

h) T: oil temperature data, integer with symbol (two bytes), high order first, unit as ℃.

i) λ: Excessive air coefficient data, integer with symbol(2bytes), high order first, unit as 100 times of the actual. For example, the measurement result of λ is 1.03, the λ data will be 0067H.

j) Check sum: sum of all the foregoing data, integer without symbol (two bytes, high order first, carry abandoned).

Check sum: 06H + HC + CO + CO_2 + O_2 + NO(NOT FOR NHA-405) + n + T + λ

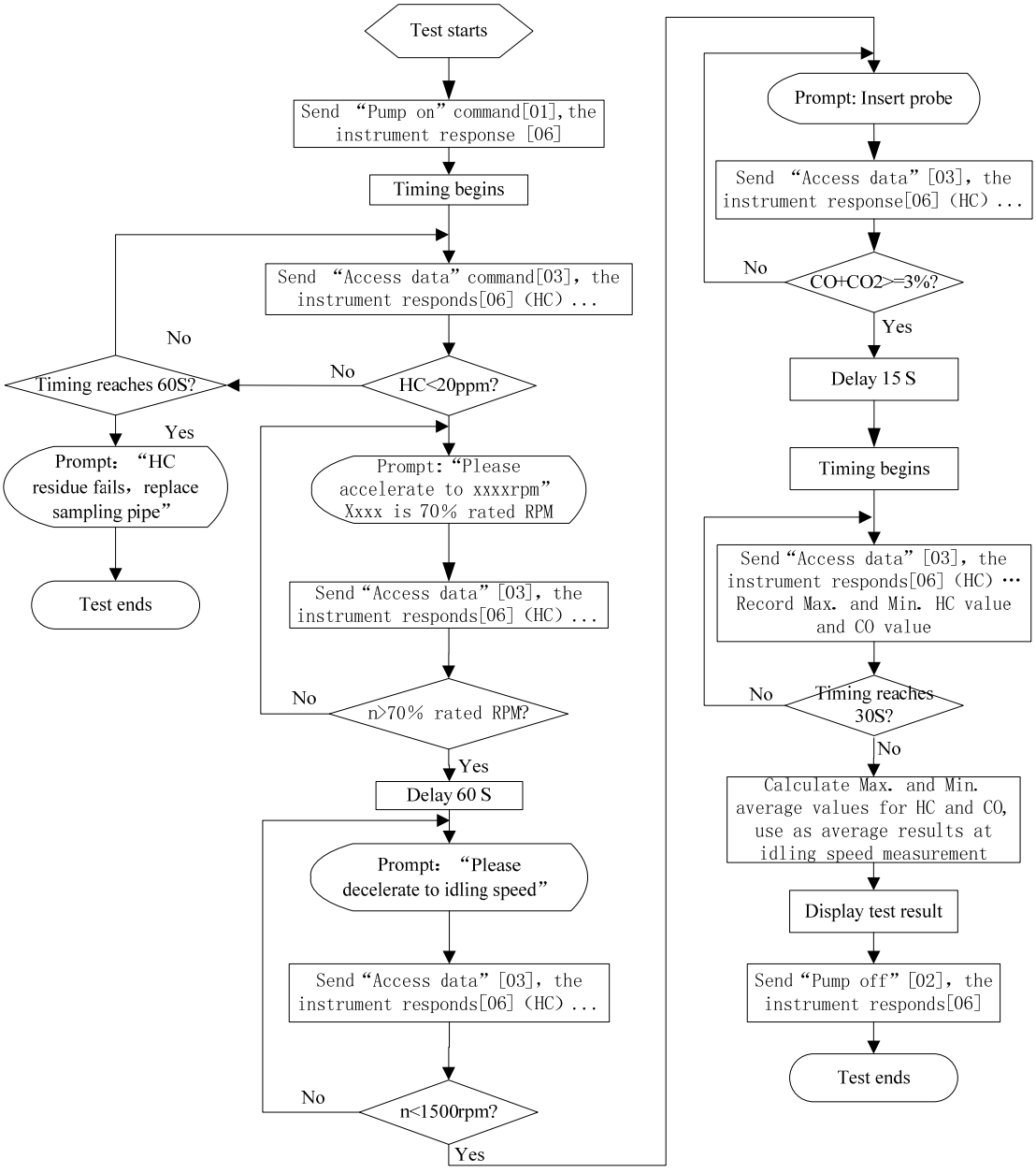


Figure 12 Communication Flow for Idling Measurement

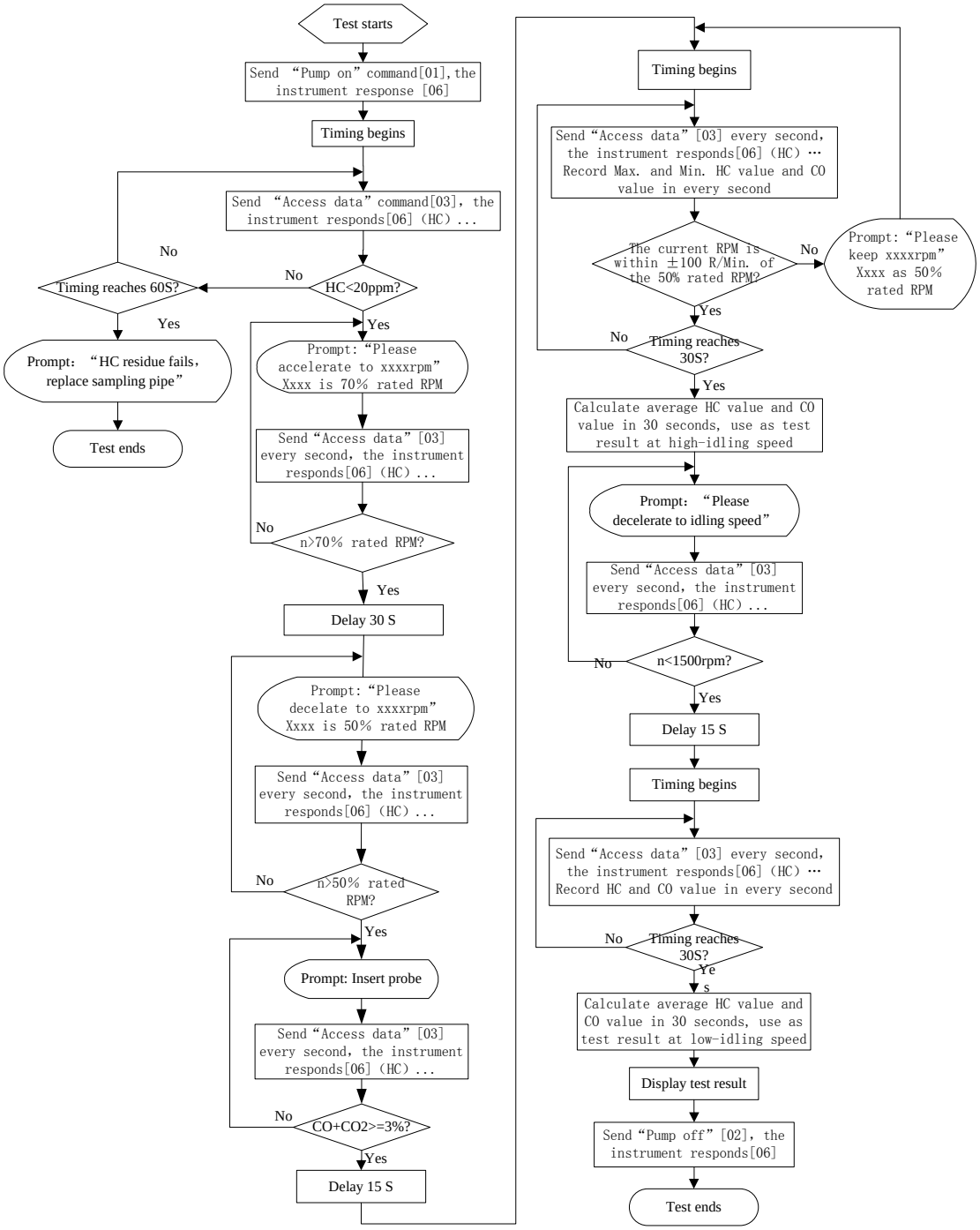


Figure 13 Communication Flow for Dual-Idling Measurement

6. Maintenance and Repair

6.1 How to Open the Instrument Enclosure?

Open the instrument enclosure for maintenance or repair in following steps:

a) Press and take off the front cover plate from the printer as shown in the chapter of "Installation of Printer Ribbon" in the <<Operation Manual of Micro Printer>> sent together with this instrument, take out the printer from the instrument enclosure according to the instruction described in the chapter of "Installation of Paper Roll", and carefully plug out the banded cable plug connecting with the instrument

(located at "Interface Socket" in the outline drawing of the "Operation Manual of Micro Printer".

b) Remove the four of fastening bolts between the casing and the base plate and the two fastening bolts over the standard gas inlet on the back plate of the instrument. Turn the two sidewalls of the casing slightly outward, pull the casing backward at the same time to remove the casing and open the instrument enclosure.

6.2 Filter Element Replacement

In case that the sampling system is clogged by dust, oily mud or any other dirt in emissions, with the flow of the sampling system seriously reduced, the measuring scale for flow on the right lower corner of the display will be less than two grids, and the symbol of "Flow" below the measuring scale will flash. Under such circumstance, cut off the power to the instrument, check and clean the sampling probe, sampling pipe and short tube, replace the filtering elements of the pre-filter and water filter. After eliminating the clogging, the instrument will recover the normal operation.

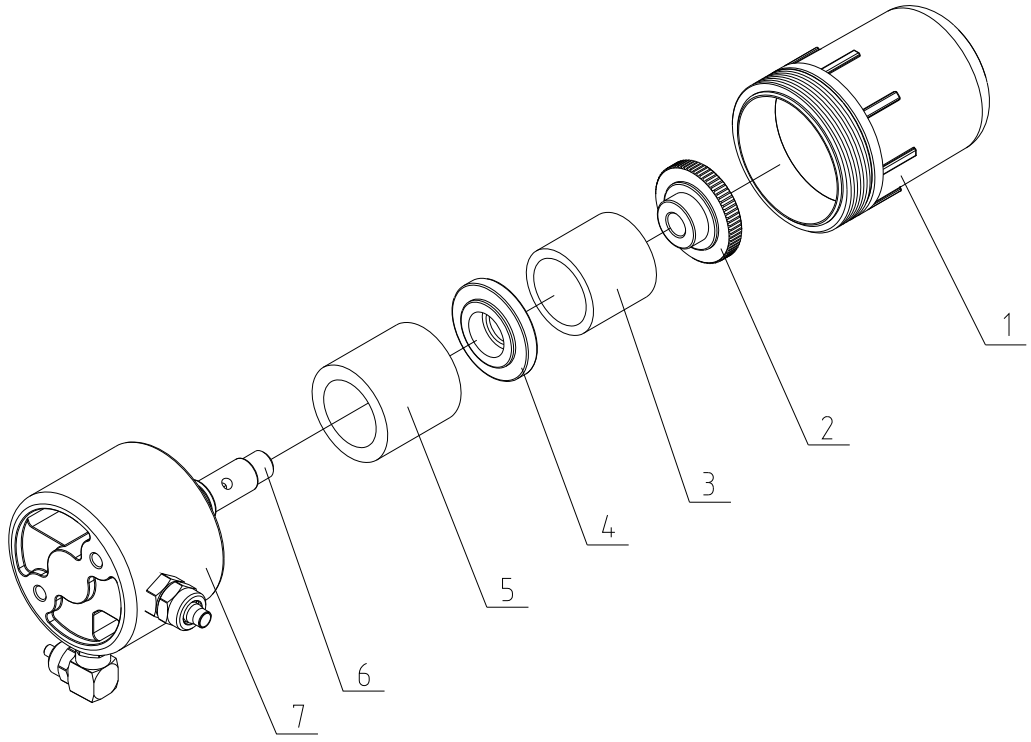
6.2.1 Replacing Pre-Filter

a) Uninstall the sampling pipe and the short tube from the failed pre-filter.

b) Take the new pre-filter from the instrument accessories, connect it with the sampling pipe and short tube as per the flow direction arrow marked on the shell (see Fig. 1)

6.2.2 Replacing Filter Element of Water Filter

As shown in Fig. 14, turn the water trap of the water filter counterclockwise and take it off, loosen the fastening bolt, remove the failed big/small filter element and clamping ring, replace them with new ones. Install all the parts in reverse sequence. Never scratch the surface by hard object when assembling the new filtering element, otherwise the filtering will be affected.

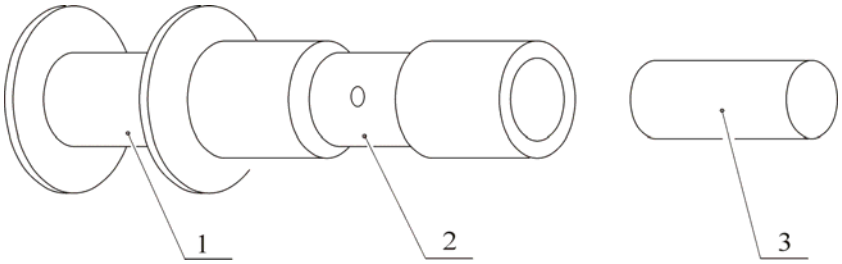


1-Water trap；2-Screw；3-Small Filter Element (P/N: KF-3060)；4-Clamp Ring；5-Big Filter Element (P/N: CF-3580)；6-Bolt；7-Base

Figure 14 Water Filter

6.2.3 Replacing Filter Element of Secondary Filter

As shown on Fig. 15, pull the handle of the secondary filter, take out the old one and replace it with a new one.



1-Handle; 2-Sheath; 3-Filter Element

Figure 15 Replacement of Filter Element

6.3 Reasons and Solution for Failed HC Residue Checking

6.3.1 Reasons for HC Residue

The excessive HC residue is caused by excessive HC in automotive emissions or excessively long measuring time, HC is deposited or absorbed in the piping and components of the sampling system.

6.3.2 Treatment for HC Residue 1

Put the sampling probe in clean air, select "General Measurement" and work under the status of "Measuring….." for some time (1-3 minutes). Let clean air blow off the HC residue in the piping, run "Check HC Residue". If this method does not work, uninstall the sampling probe and sampling pipe, use compression air to blow them.

6.3.3 Treatment for HC Residue 2

If the ways described in 6.3.1 do not work, replace the filter elements of the pre-filter, water filter and secondary filter.

6.4 Reasons and Treatments for Failed Leak Check

a) The inlet of the sampling probe is not firmly blocked which causes leakage – re-block it and re-test.

b) Leakage at the connection of the sampling probe – connect and tighten it again.

c) Leakage due to breakage or punching of sampling pipe – replace it with a new sampling pipe.

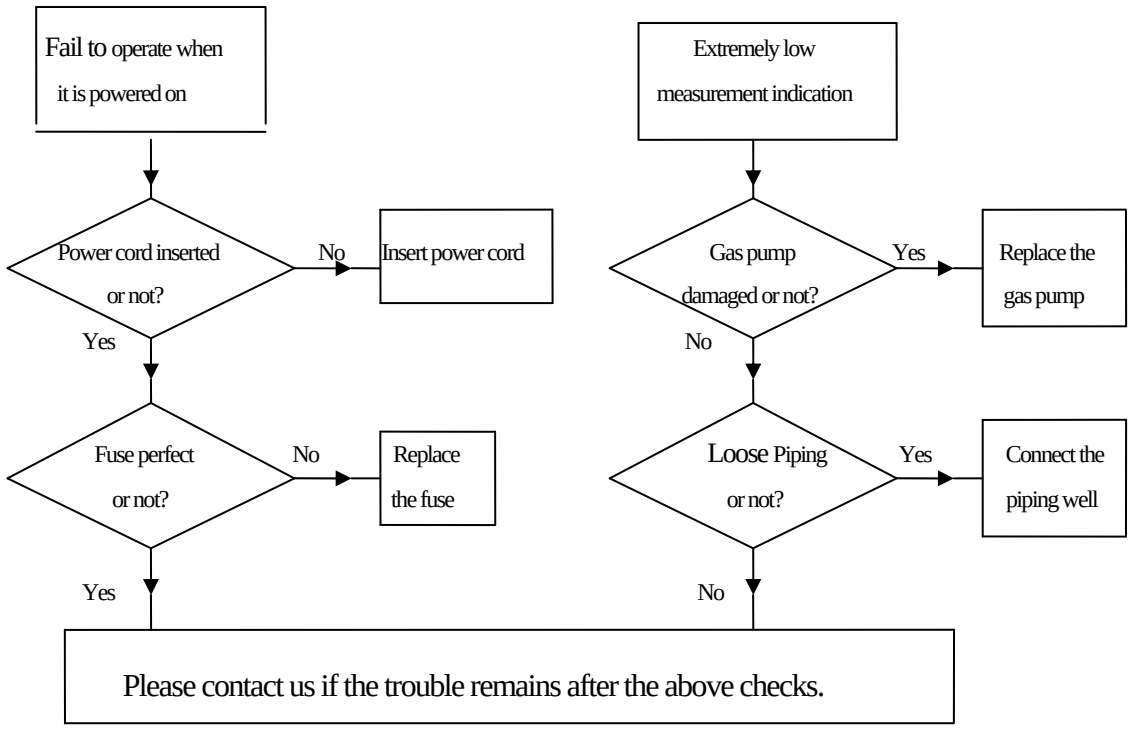
d) Ageing ends of the sampling pipe or short tube, which causes poor sealing – cut off the ageing section or replace it with a new sampling pipe.

e) Leakage at the connection between the water cup and assembly – check if the gasket is broken or lost, check the connections. Replace the gasket or re-assemble it.

f) Leakage at the sheathing of the secondary filter: the sheathing is not inserted well to the desired position. Insert it again to the end.

g) Leakage caused by broken gas cell of the pump, replace it.

6.5 Simple Troubleshooting



6.6 Replacing Print Paper and Printer Ribbon

Replace the print paper and ribbon according to the operation method in the "Installation of Paper Roll" and "Installation of Print Ribbon" in the "Operation Manual of Micro Printer" sent together with this instrument. Roll up the paper-roll firmly during assembling. otherwise, the print paper may be gripped with poor feeding.

7. Excessive Air Coefficient (λ) and Air-Fuel Ratio (A/F)

7.1 Theoretic fuel combustion

The theoretic fuel combustion is complete oxidization of the carbon element C and hydrogen element H by the oxygen in air, and produce CO_2 and H_2O only. The molecular formula of hydrocarbon fuels is CnHm, in which, n is the number of carbon atoms, m is the number of hydrogen atoms. Its chemical reaction equation is:

$$CnHm + (n + m/4)O_2 + 3.76\,(n + m/4)N_2 = n\,CO_2 + (m/2)H_2O + 3.76\,(n + m/4)N_2$$

Due to calculation by volume, O_2 in the air is about 21% and N_2 about 79%, which means that each oxygen molecule in the air is equivalent to 79/21 = 3.76 units of nitrogen molecules. Therefore, the N_2 coefficient in the above equation shall be multiplied by 3.76.

7.2 Excessive air coefficient

The air volume required for theoretic fuel combustion is called theoretic air volume. Actually, the air supplied during the operation of engine is always greater or less than the theoretic air volume. In order to

determine the actual air volume supplied during the operation of engine, excessive gas coefficient λ is often used.

$\lambda = L/L0$

where, λ means the excessive air coefficient;

L means the actual air volume supplied during the operation of engine with the combustion of 1kg fuels; and

L0 means the theoretic air volume required during the operation of engine with the combustion of 1kg fuels.

The mixture air with $\lambda = 1$ is called the theoretic mixture air or standard mixed air. The mixture air with $\lambda > 1$ is called the thin mixture air, and the greater the λ amount exceeding 1. The more air than the fuel, and the thinner the concentration of the mixed air. The mixture air with $\lambda < 1$ is called the thick mixture air, and the greater the λ amount less than 1, the less air than the fuel, and the thicker the concentration of the mixture air.

7.3 Air-Fuel Ratio

The concentration of the mixture air can be evaluated by air-fuel ratio (AFR), namely, the ratio between the actual air volume supplied A with the actual fuel supplied F – A/F. The greater the air-fuel ratio (A/F), the thinner the concentration of the mixed air, and the less the air-fuel ratio (A/F), the thicker the concentration of the mixed air. The air-fuel ratio (A0/F) in theoretic combustion is called the theoretic air-fuel ratio.

7.3.1 Using Cyclohexane (C_6H_{12}) as Gasoline for Theoretic Combustion

The chemical reaction equation is as the follows,

C6H12+(6+12/4)O2+3.76(6+12/4)N2=6 CO2+(12/2)H2O+3.76(6+12/4)N2

The theoretic air volume required A0 (L0) is: $A0 = (6 + 12/4)O_2 + 3.76\ (6 + 12/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (6 + 12/4) \times 2 \times 16 + 3.76 \times (6 + 12/4) \times 2 \times 14 = 1235.52$

The fuel volume of cyclohexane (C_6H_{12}) is: $F = C_6H_{12}$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 6 \times 12 + 12 \times 1 = 84$

The theoretic air-fuel ratio A0/F = 14.7

7.3.2 Using Isooctane (C_8H_{18}) as Gasoline for Theoretic Combustion

The chemical reaction equation is as the follows,

$C_8H_{18} + (8 + 18/4)O_2 + 3.76\ (8 + 18/4)N_2 = 8\ CO_2 + (18/2)H_2O + 3.76\ (8 + 18/4)N_2$

The theoretic air volume required A0 (L0) is: $A0 = (8 + 18/4)O_2 + 3.76\ (8 + 18/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (8 + 18/4) \times 2 \times 16 + 3.76 \times (8 + 18/4) \times 2 \times 14 = 1716$

The fuel volume of isooctane (C_8H_{18}) is: $F = C_8H_{18}$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 8 \times 12 + 18 \times 1 = 114$

The theoretic air-fuel ratio A0/F = 15

7.3.3 Using Propane (C_3H_8) as Gasoline for Theoretic Combustion

The chemical reaction equation is as the follows,

$C_3H_8 + (3 + 8/4)O_2 + 3.76\,(3 + 8/4)N_2 = 3\,CO_2 + (8/2)H_2O + 3.76\,(3 + 8/4)N_2$

The theoretic air volume required A0 (L0) is: $A0 = (3 + 8/4)O_2 + 3.76\,(3 + 8/4)N_2$

Take the atomic weights of O and N into the above equation, and the result is:

$A0 = (3 + 8/4) \times 2 \times 16 + 3.76 \times (3 + 8/4) \times 2 \times 14 = 686.4$

The fuel volume of propane (C_3H_8) is: $F = C_3H_8$

Take the atomic weights of C and N into the above equation, and the result is:

$F = 3 \times 12 + 8 \times 1 = 44$

The theoretic air-fuel ratio A0/F = 15.6

7.4 Correlation between Excessive Air Coefficient λ and Air-Fuel Ratio A/F

Cyclohexane (C_6H_{12}) is used as gasoline: $A/F = 14.7\,\lambda$

Isooctane (C_8H_{18}) is used as gasoline: $A/F = 15\,\lambda$

Propane (C_3H_8) is used as gasoline: $A/F = 15.6\,\lambda$

8. RPM Measurement

Engine ignition pulse is used to indirectly measure revolving speed. As the engine types and models are various, the styles and performance are different. The RPM measurement of this instrument is not possible to be effective to all the engines and the effectiveness is about 80%. If it is not able to test some engines, we suggest use other measuring methods.

There will have great interference in some engines. When RPM and oil temperature is measured, slow data update will cause abnormal operation due to the interference. Try to take out the oil temperature probe. If this does not work, use other measurement methods.